

Introduction

In botany and horticulture, **deciduous plants**, including trees, shrubs and herbaceous perennials, are those that lose all of their leaves for part of the year. This process is called abscission. In some cases leaf loss coincides with winter namely in temperate or polar climates. In other parts of the world, including tropical, subtropical, and arid regions, plants lose their leaves during the dry season or other seasons, depending on variations in rainfall.

Many deciduous plants flower during the period when they are leafless, as this increases the effectiveness of pollination. The absence of leaves improves wind transmission of pollen for wind-pollinated plants and increases the visibility of the flowers to insects in insect-pollinated plants. This strategy is not without risks, as the flowers can be damaged by frost or, in dry season regions; result in water stress on the plant.

Spring leaf out and fall leaf drop are triggered by a combination of daylight and air temperatures. The exact conditions required will vary with the species, but generally more cold-tolerant genera such as *Salix* will leaf-out earlier and lose their leaves later, while genera such as *Fraxinus* and *Juglans* can only grow in warm, frost-free conditions so they need at least (13) hours of daylight and air temperatures of around (21 °C) to leaf out. They will be among the earliest trees to lose their leaves in the fall. In sub-Arctic climates such as Alaska, leaves begin turning colors as early as August. However, for most temperate regions it takes place in late September through early November and in subtropical climates such as the southern US, it may be November into December.

Abscission:

Leaf drop or abscission involves complex physiological signals and changes within plants. When leaf out is completed (marked by the transition from bright green spring leaves to dark green summer ones) the chlorophyll level in the leaves remains stable until cool temperatures arrive in autumn. When autumn arrives and the days are shorter or when plants are drought-stressed, the chlorophyll steadily breaks down, allowing other pigments present in the leaf to become apparent and resulting in non-green colored foliage. The brightest leaf colors are produced when days grow short and nights are cool, but remain above freezing. These other pigments include carotenoids that are yellow, brown, and orange. Anthocyanin pigments produce red and purple colors, though they are not always present in the leaves. Rather, they are produced in the foliage in late summer, when sugars are trapped in the leaves after the process of abscission begins.

The elongation of these cells breaks the connection between the different cell layers, allowing the leaf to break away from the plant. It also forms a layer that seals the break, so the plant does not lose sap. Some trees, particularly oaks and beeches, exhibit a behavior known as "**Marcescence**" whereby dead leaves are not shed in the fall and remain on the tree until being blown off by the weather. This is caused by incomplete development of the abscission layer. It is mainly seen in the seedling and sapling stage, although mature trees may have marcescence of leaves on the lower branches.

The beginnings of leaf drop starts when an abscission layer is formed between the leaf petiole and the stem. This layer is formed in the spring during active new growth of the leaf; it consists of layers of cells that can separate from each other. The cells are sensitive to a plant hormone called auxin that is

produced by the leaf and other parts of the plant. When auxin coming from the leaf is produced at a rate consistent with that from the body of the plant, the cells of the abscission layer remain connected; in autumn, or when under stress, the auxin flow from the leaf decreases or stops, triggering cellular elongation within the abscission layer.

In the fall or when under stress, the leaf's auxin production decreases causing a reduction in cellular elongation on the leaf side of the abscission layer. The difference in the elongation rates of cells in opposite sub-layers within the abscission layer causes a break in the connection between the two cell sub-layers, allowing the leaf to break away from the plant. At the same time the cells in the sub-layer remaining on the plant body side of the abscission layer form a seal so the plant does not lose sap.

A number of deciduous plants remove nitrogen and carbon from the leaves before they are shed and store the nitrogen and carbon in the form of proteins in the vacuoles of parenchyma cells in the roots and the inner bark. In the spring, these proteins are used as a nitrogen source during the growth of new leaves or flowers.

Changes in pigment concentration are also part of the physiological changes. The process of photosynthesis steadily degrades the supply of chlorophylls in foliage. Plants normally replenish chlorophylls during the summer months. When days grow short and nights are cool in temperate and Arctic environments, or when plants are drought stressed, deciduous trees decrease chlorophyll pigment production. For some species in cooler climates, this allows other pigments present in the leaf to become apparent, resulting in fall colors. These other pigments include carotenoids, which are yellow, brown, and orange. Anthocyanin pigments, which produce red and purple colors in the fall

foliage, are not always present in the leaves; they are produced in the foliage in late summer when sugars are trapped in the leaves after the process of abscission begins. Parts of the world that have showy displays of bright fall colors are limited to locations where days become short and nights are cool. In other parts of the world, the leaves of deciduous trees simply fall off without turning the bright colors produced from the accumulation of anthocyanin pigments.

Advantages and disadvantages:

Deciduous trees shed their leaves usually as an adaptation to a cold season or a dry season. Most tropical rainforest plants are evergreens, replacing their leaves gradually throughout the year as the leaves age and fall, whereas species growing in seasonally arid climates may be either evergreen or deciduous. Most warm temperate climate plants are also evergreen. In cool temperate climates, fewer plants are evergreen, with a predominance of needle-leaf conifers, as few evergreen broadleaf plants can tolerate severe cold below about (-30 °C).

Plants with deciduous foliage have advantages and disadvantages compared to plants with evergreen foliage. Since deciduous plants lose their leaves;

- (1) To conserve water.
- (2) To better survive winter weather conditions.
- (3) They must regrow new foliage during the next suitable growing season; this uses resources which evergreens do not need to expend.
- (4) Deciduous trees experience much less branch and trunk breakage from glaze ice storms when leafless and plants can reduce water loss due to the reduction in availability of liquid water during cold winter days.
- (5) Losing leaves in winter may reduce damage from insects.

- (6) Repairing leaves and keeping them functional may be more costly than just losing and regrowing them.
- (7) Removing leaves also reduces cavitation which can damage xylem vessels in plants. This then allows deciduous plants to have xylem vessels with larger diameters and therefore a greater rate of transpiration (and hence CO₂ uptake as this occurs when stomata are open) during the summer growth period.
- (8) Evergreens suffer greater water loss during the winter and they also can experience greater predation pressure, especially when small.

In areas where there is a reason for being deciduous (for example, a cold season or dry season), being evergreen is usually an adaptation to low nutrient levels. Deciduous trees lose nutrients whenever they lose their leaves, and to build new leaves they must replenish from the soil whatever of the nutrients they have not been able to store over the winter as storage proteins. When few nutrients are available, evergreen plants have an advantage. In warmer areas, species such as some pines and cypresses grow on poor soils and disturbed ground. In *Rhododendron*, a genus with many broadleaf evergreens, several species grow in mature forests but are usually found on highly acidic soil where the nutrients are less available to plants. In taiga or boreal forests, it is too cold for the organic matter in the soil to decay rapidly, so the nutrients in the soil are less easily available to plants, thus favoring evergreens. In temperate climates, evergreens can reinforce their own survival through evergreen leaf and needle litter contributing to a higher soil acidity and lower soil nitrogen content, or the shelter of existing evergreen plants making it easier for other evergreen plants to survive cold and/or drought (Aerts 1995).

Regions:

Forests where a majority of the trees lose their foliage at the end of the typical growing season are called deciduous forests.

Two distinctive types of deciduous forests are found growing around the world.

1 - Temperate deciduous forest: biomes are plant communities distributed in North and South America, Asia, Southern slopes of the Himalayas, Europe and for cultivation purposes in Oceania. They have formed under climatic conditions which have great seasonable temperature variability with growth occurring during warm summers and leaf drop in autumn and dormancy during cold winters. These seasonally distinctive communities have diverse life forms that are impacted greatly by the seasonality of their climate, mainly temperature and precipitation rates. These varying and regionally different ecological conditions produce distinctive forest plant communities in different regions.

2 - Tropical and subtropical deciduous forest: biomes have developed in response not to seasonal temperature variations but to seasonal rainfall patterns. During prolonged dry periods the foliage is dropped to conserve water and prevent death from drought. Leaf drop is not seasonally dependent as it is in temperate climates, and can occur any time of year and varies by region of the world. Even within a small local area there can be variations in the timing and duration of leaf drop; different sides of the same mountain and areas that have high water tables or areas along streams and rivers can produce a patchwork of leafy and leafless trees.