LIFE AND DEATH OF A TREE

Dr. Carl Whitcomb, Lacebark Research, Stillwater, OK

Many trees live to ripe old ages. But in the natural forest, each large old tree represents only a fraction of the number of trees that began on the site. What happened to the rest of them? A few trees die from disease. Dutch elm disease, chestnut blight, verticillium and oak wilt are often fatal. But in the big picture, these are minor players. Trees growing on poor soils grow slower than those on better soils; however they do not necessarily have a shorter life. In cities and some urban areas where space suitable for root growth is limited, life is shorter and may be only a few years. This begs two fundamental questions – How do trees grow and why do they die? Trees grow because they produce sufficient energy to produce new cells and expand. But, bluntly put, unless killed directly by disease, trees die because they starve to death. The question then becomes how to maximize energy production and avoid starvation.

Trees, in fact all plants and all life, run on energy. The difference between a tree and your car is trees manufacture their own energy (sugars) through the amazing chemical machinery called photosynthesis and as part of that process give off oxygen. Energy is produced in leaves and other green tissues. The burning of energy, called respiration, consumes oxygen and gives off $CO2$ and is also required by all living cells in order to survive. But energy produced by leaves is not evenly distributed. There is a distinct peck-order or order of distribution of energy that is roughly flowers, fruits, leaves, stems and roots. The fundamental goal of plants (as well as everything else) is to reproduce the species, thus when flowers and developing fruits (seeds) are present, they have priority. When flowers are finished and seeds are mature, the distribution then becomes leaves, stems and roots. Roots are at the end of the distribution system.

As a tree increases in size, it has more leaves and can produce more energy for growth. But growth comes at a price: the living cells in all flowers, fruits, leaves, stems and roots must be maintained with adequate energy or they die.

Energy output of green leaves is dependent on a variety of factors; sunlight, water, carbon dioxide and 12 essential nutrient elements. Total energy output is controlled by the most limiting factor. For example, if the essential element, copper, is most deficient, adding additional nitrogen, phosphorus or any other element will not increase energy output. If copper is applied, energy output will increase up to the point where some other element or factor becomes limiting. This creates a temptation to add more of everything. But that may do more harm than good as each essential element has an optimum concentration. Below the optimum, plant growth may be restricted due to deficiency. Above the optimum, at some point, concentration of an element can become toxic. The challenge has been to try to identify the optimum range for each of the 12 essential elements.

Sunlight and carbon dioxide are more or less constants. Plants have a marvelous mechanism whereby leaves in full sun can avoid excess light and leaves in partial shade can be made more efficient by positioning of the chloroplasts.

Water is also a plant growth regulator and something we can and often do attempt to monitor and supplement as needed. Oxygen in soil is crucial for respiration of roots. As water in soil increases, oxygen decreases. But here a balance is clearly needed. To have an abundance of water to the point of exclusion of oxygen is very undesirable and vice versa. Providing water to a tree when soil becomes extra dry is probably beneficial, but not always.

Consider a season where a tree made a normal amount of growth in spring, and has a full complement of leaves. As summer progresses, rainfall slows, and soils become dry. The tree typically has access to sufficient moisture to sustain leaves for a time. But if the drought becomes severe, some species will at first drop oldest leaves that are least energy efficient, then gradually younger and younger leaves to balance moisture available to moisture loss. Birch, sycamore, poplars and other trees make this adjustment noticeably. As leaves are lost, energy output decreases, but a healthy plant typically has sufficient reserves to last through such emergencies.

Now consider a tree like the one just described only with sufficient irrigation water applied during a drought to trigger the tree to make a new flush of growth. Now the tree has the old complement of leaves, plus new ones to support. As long as sufficient irrigation water is supplied all is well. But, if the irrigation system breaks or the homeowner forgets or goes on vacation, the tree is left under severe stress.

New leaves lose water at a greater rate than old leaves, so water loss per day is far greater than a non irrigated tree that has only to maintain old leaves. But the problem is more severe than just water loss. To make the new flush of growth, considerable stored energy was required. If most of the old leaves and some of the new leaves are lost prematurely, recovery of energy spent is unlikely. And, unless energy recovery occurs, twigs and buds on new growth will not mature properly to support a normal flush of growth next spring. Plus, the tree will have to endure winter with less than a normal quantity of energy reserves.

Figure 1. This large, healthy tree is an example of when all management aspects are met.

The complications continue. Roots are at the end of the energy distribution system. Whenever a tree (or any plant), experiences reduces energy production, the stress can always be detected in roots first. Reduced root growth reduces nutrient uptake, further complicating recovery. At first, this seems peculiar, even backwards, but primary law of the biological jungle is survival of the fittest. Once a plant shows weakness, its demise is hastened.

Figure 2. Due to a poor root system and incorrect planting depth, this tree failed to produce sufficient roots at the new site and is struggling to survive.

This leaves the strongest and most adaptable individuals to reproduce the species and makes way for new seedlings. Lives of many plants are complicated by excesses. Once established, most trees are better off without irrigation, except under extreme conditions.

A Few Key Points of Plant Nutrition.

1. Nitrogen is the main element needed, but more is not better. Excesses may cause more harm than mild deficiencies.
2. Soils are complex mixtures of minerals and debris. Soils are infinitivally variable within a field and especially in most landscapes.
3. Apply fertilizer to the entire landscape. Roots, especially of established trees, extend far beyond the drip line, making specific tree treatment impractical.
4. Adding fertilizers without knowing what is already present is like throwing darts in the dark.

5. A good soil test is a must. If you have adequate phosphorus, in most soils, adding more is detrimental to plant health.

6. The big players are calcium, phosphorus and sulfur.

A. Calcium is the bully element and dominates whenever present in excess. Calcium is deficient below roughly 600 lbs per acre (300 ppm) and increasingly can cause problems at levels above 2,000 lbs per acre (1,000 ppm).

B. Phosphorus is deficient below about 40 lbs per acre (20 ppm) and can cause problems starting about 100 lbs per acre (50 ppm). Excess P forms complexes with calcium, iron, manganese and other elements to form insoluble phosphate rock! Excess applications of phosphate fertilizers have turned many landscapes into low grade phosphate mines.

C. Sulfur is often overlooked, but is very important. Sulfur levels should be between 40 and 100 lbs per acre (20 to 50 ppm). Sulfur is also a key element in lowering soil pH. As soil pH goes down, availability of iron, manganese and other micronutrients increases.

7. Most irrigation waters contain from low to extremely high levels of calcium, sodium and bicarbonates. Every time water is applied, minerals are applied. Water evaporates and minerals are left behind, just like in a tea kettle. Over time, minerals in irrigation water can have a dramatic effect on soil chemistry. The only way to know and take corrective measures is by periodically testing water and soils.

*** Adapted from Establishment and Maintenance of Landscape Plants II, by Carl Whitcomb, published 2006. For more information visit www.lacebarkinc.com.