What Keeps the Green Side Growing Up, and the Brown Side Growing Down?

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Trees come in a wide variety of shapes and sizes. This is in large part due to the tremendous number of different species that have evolved to occupy different parts of the forest environments. But why can trees of the same species look very different? Part of the explanation, of course, is that trees within the same species vary genetically. Trees of the same species can vary in appearance the same way people vary in appearance (though we are all the same species). Another important control of tree growth that results in a variety of shapes and forms is that of hormones.

trees have a number of different hormones, or growth regulators, that control the growth and behavior of the tree right at the level of the individual cell. Some of these regulators stimulate cell growth, and others inhibit it. These regulators interact with one another in the tree, and the overall result is a tree of unique shape and form.

Where are these hormones, and how do they work? They are produced primarily in the shoot tips, root tips, or leaves, and are soluble in water. This enables them to travel either up through the tree with water extracted by the roots from the soil, or down through the tree with sugars that were manufactured in the leaves. They are present in trees only in extremely small amounts — often less than one part per million — which makes them extremely difficult for scientists to study. Nevertheless, they have an extraordinary influence on the way trees grow.

Hormone interactions in trees control some of the basic events that we observe. For example, the breaking of bud dormancy in the spring is controlled by hormones. Those that inhibit the buds from unfolding gradually break down, and those that stimulate growth increase. The result is the green flush of new growth that we enjoy in the spring. When would a hormone that inhibits growth be useful for a tree? The reverse process takes place in the summer and fall, when growth-inhibiting hormones begin to dominate. This results in the cessation of shoot growth, the formation of buds to protect next year's fragile growth from the harsh winter environment, and (in the case of deciduous trees) the eventual falling of leaves to the forest floor.

Tree hormones also direct the growth of the stem in the upward direction, and the roots in a downward one. If a tree is tipped, for example, by a high wind, its ability to "bend up" and grow vertically is due to hormones. They travel to one side of the tree and make the cells there grow more, thus making the stem "bend," so to speak. The same thing occurs when houseplants "bend" towards the light in a room. Hormones are present in greater concentrations on one side of the plant, and the stimulated growth on that side makes the plant lean in a particular direction.

The notions of trees growing straight up, or leaning towards light in a forest, are subtle ones that we take for granted. The actions of hormones in trees can be much more dramatic, however. The concentrations of hormones in the shoots and stem regulate the degree to which the shoots throughout the tree will elongate. This is called "apical dominance," and insures that

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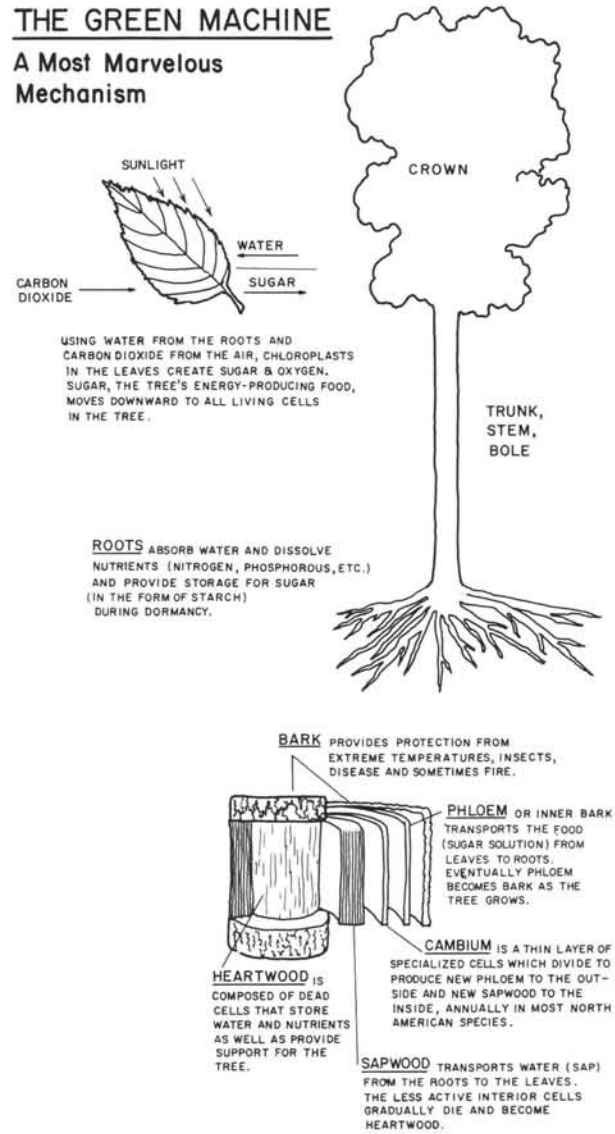
THE GREEN MACHINE

A Most Marvelous Mechanism



the tree's main stem, or ''leader,'' will continue to grow up, and the other secondary branches will grow out to the side. If an insect kills back the main leader, or an animal eats it, the tree loses a main source of hormonal production and control. The balance is upset by the absence of one hormone, and the result is a change in the form of the tree. In the case of eastern white pine and the white pine weevil, when the main leader is infested and dies, one (or several) of the lateral branches begins to ''bend up'' and assume the dominant vertical position. After repeated weevil atttacks, the tree can have multiple main stems, all of which are crooked, due to their having been ''bent up.'' These ''cabbage pines'' are characteristic throughout thew New England landscape, and are the result of the external influence of the weevil and the internal response of the tree's homones.

Long before people understood that trees had hormones, they were using one of the results of hormonal response to their advantage. In medieval Europe (and later in colonial America), firewood was the principal source of energy for heating and cooking. People knew that if they cut down certain species of hardwoods, they would sprout again from the stump and continue to grow. Every 20 or 30 years, they would return to the same few acres of forest and cut it all back again for firewood, with the knowledge that it would re-sprout. This was known as coppice cutting. (continued page 10)

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American chestnut continues to exhibit the same kind of hormonal response when it is repeatedly killed back by the Chestnut Blight fungus. Trees of this species have been dying back and re-sprouting since the blight swept through New England in the early decades of this century. This behavior is another example of the loss of "apical dominance" or hormonal balance in the tree, resulting in the sprouting of what would otherwise be dormant buds at the base of the tree.

Based on a developing understanding of the role that hormones play in tree growth and form, forest scientists today are using hormones in research to clone superior trees. Tissue from such trees is taken back to the laboratory and grown in test tubes in the presence of hormones that will stimulate root and shoot formation. The resulting "little trees" (not actually seedlings) can then be planted. Knowledge of tree hormones has also resulted in the development of herbicides that are lethal to trees. These herbicides are an artificial form of hormone that stimulates exessive growth and peculiar physiological behavior which results in tree death.

Scientists continue to study the role that hormones play in tree growth. Much is yet to be learned about the interesting form of "communication" within a tree. Based on numerous external environmental stimuli such as day length or temperature, hormone balances in a tree change, and leaves fall, buds unfold or flowers appear. Shoot elongation and the degree of "apical dominance" is also controlled by hormones. Also, a tree's response to injury or external influences such as weevil infestation, high winds, animal browsing, or felling is controlled by hormones. The relative presence in minute quantities of these important hormones plays a signigicant role in determining the growth and form of the trees we enjoy today.

Poa annua Control

Poa annua remains a serious problem facing many golf course superintendents. Over the last several years new information has come out concerning **Poa annua** control. Research at Michigan State University by Gaussoin and Branham has shown that collection of clippings and elimination of overwatering can reduce the amount of **Poa annua** in fairways. When attempting to reduce **Poa annua** in fairways the first step is to develop a management system to favor the desired turf species and then supplement proper management with chemical control measures.

Progress has received much attention as a preemergence and postemergence herbicide for **Poa annua** control. Turfgrass researchers from several universities report excellent success with Progress. Several factors are very important to keep in mind when using Progress. The first is to accurately assess the amount of annual bluegrass present. If the amount of annual bluegrass is underestimated there could be numerous bare or thin areas the following spring that golfers would find objectionable. Two applications of Prograss, 3 to 4 weeks apart, are a must. The applications can be made between September and December. The annual bluegrass will show no symptoms of injury after the first application. Few, if any symptoms of injury will be seen after the second application. The results of applications made in the fall will be observed the following spring in a reduction in the amount of **Poa annua** present. The annual bluegrass treated with Prograss dies during the winter. Often an overseeding program is needed in conjunction with the use of Prograss to provide turf cover in bare or thin areas.