Secrets of Fall Color Unlocked at UW - Madison

By Monroe S. Miller, *Golf Course Superintendent, Blackhawk Country Club*

I love to follow the change in seasons from the promontory that dominates the eastern end of our golf course and overlooks Lake Mendota.

The snow of winter, the blossoms of spring and the expansive green of summer are beautiful from there. But my favorite scene is the color created by tree leaves in autumn.

Science has understood for quite a time the processes that give us the showy brilliance of fall color.

Plant leaves use sunlight, water and carbon dioxide in the presence of chlorophyll and through the process of photosynthesis to produce glucose. Chlorophyll gives plant leaves their green color.

Pigments other than chlorophyll are present in leaves. Xanthophyll is a yellow pigment, carotene is orange (like carrots) and anthocyanin is a red pigment. During summer the large amount of chlorophyll masks the red, orange and yellow colors of these and other pigments.

Sugar production in leaves goes down as the shorter days and cooler temperatures of fall arrive. Chlorophyll production declines and the colors of the other pigments start to dominate over green. Tannin, another pigment, turns oak leaves brown as it overpowers the green of the chlorophyll.

The fall color of an individual tree depends on the infinite proportions possible of the various pigments in the leaves, along with other factors such as soil moisture, nutrient levels, weather conditions and the health of the tree. Leaves on the sunny side of a tree will be redder while the leaves on the shady side will be more yellow.

An abscission layer forms at the

base of the petiole, slowly closing the veins between the leaves and the wood. Sugars produced during the day are trapped in the leaf at night, adding to the color of that leaf.

Despite all that is known about the fall color of leaves, there are always unknowns and some processes that are imperfectly understood. Botanists are now rethinking that fall colors are merely by-products of dying leaves.

A biologist from Oxford University, Dr. William Hamilton, proposed that the bright color of autumn leaves was a signal to various insects to stay away. His "leaf signal" hypothesis suggested that brightly colored leaves evolved because insects avoided them. Insects that over winter as eggs on tree bark cause damage to trees when they hatch in the spring. This damage is caused by the larvae feeding on the new, spring leaves.

As the insects avoided trees with bright fall colors, natural selection favored trees that were even brighter.

Hamilton's theory was so appealing that other botanists initiated experiments to test it. One of those is Dr. William Hoch, a plant physiologist in the Botany Department at the University of Wisconsin - Madison. Dr. Hoch's research on fall color was featured in the October 19,2004 issue of *Science Times*, the weekly New York Times science section.

Dr. Hoch's research has led him to explain that fall colors serve primarily as a sunscreen. "If you are up here in Wisconsin, by the time the leaves change, all the insects that feed on foliage are gone," Dr. Hoch said in the *Times* article.

In the fall much of the photosynthetic process has declined and isn't working efficiently. Leaves cannot capture all of the sunlight falling on them and leftover energy can cause tissue damage to the leaves. The anthocyanin pigments serve to block some of that sunlight so the leaf can continue producing sugars to help the tree over winter.

Hoch and his grad students raised some normal trees along side of mutants that were unable to produce anthocyanins. The mutants survived in the greenhouse but could not move nutrients out of their leaves when moved outside in the fall.

New theories give rise to new questions and the need for more research. For example, what happens to trees like birch that do not produce anthocyanins? Dr. Hoch is starting to study that question.

As science unlocks more and more secrets of the complex process of fall color, my appreciation is actually heightened. Especially from our 10th tee.