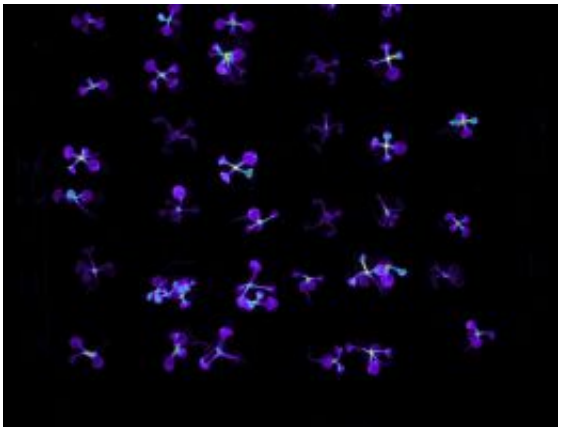
'Biological clock' genes control plant growth

September 16 2008



Genes in mustard plant seedlings glowing as they "turn on" just before dawn.

(PhysOrg.com) -- More than 125 years ago Charles Darwin first reported that most plants grow in a spurt during the night, not the day – and this week, scientists are reporting the discovery of the genes that control this phenomenon.

These rhythmic growth spurts, and the ability of plants to move in response to light, are actually controlled by genes involved in circadian rhythms – the "biological clock" genes that are influenced by light and dark, vary their activity based on time of day, and are increasingly found in both plants and animals to control a wide variety of functions, ranging from growth to nervous system function and even fertility.

"This is an incremental but important step in understanding how plants

grow," said Todd Mockler, an assistant professor of botany at Oregon State University, and co-author of the report with colleagues at the University of California/San Diego and the Salk Institute for Biological Studies.

Ultimately, more understanding of these growth genetics could allow scientists to create plants that grow faster, produce more food or have other useful characteristics, the researchers said.

The findings will be reported this week in *PloS Biology,* a professional journal. The research was funded by the National Science Foundation, National Institutes of Health and the Howard Hughes Medical Institute.

"We now know that the expression of certain genes and hormones at night and just before dawn is important for plant growth," Mockler said. "During the day, the plant focuses on other tasks, such as the photosynthesis that produces its energy. And plants are not only responding to time of day, but also the length of daylight to control such things as flowering time and stem length."

When such mechanisms are more fully analyzed, it may be possible to influence them with genetic modification, Mockler said.

This advance was made possible largely by the use of DNA microarrays and bioinformatics, most of which was done at OSU. This technology allows powerful computers to be combined with more conventional biological research to examine thousands of genes in an organism, in a very short period of time, and determine which ones are active and what their role is.

Researchers now believe that almost all plant genes are expressed only at a particular time of day, depending on the growth condition. And they use growth and movement to maximize their chance of survival in a

competitive environment – a plant leaf, for instance, will literally move if it becomes shaded by another plant.

In 1880, in one of his lesser-known works that was not focused on animal evolution, Darwin first described this phenomenon. He found that rather than growing at a steady rate, plants often grow in regular nightly spurts.

The findings in this study were made with the plant Arabidopsis, a small plant in the mustard family that is often used as a model for genetic research. A glowing enzyme, luciferase, was attached to the genes that were identified as responsible for rhythmic growth. And it would glow, on and off, as the genes began functioning to create the hormones responsible for growth in the dark of night.

The research program also learned that most of the genes involved in this process have a common DNA sequence, which they called the "HUD" element for "hormone up at dawn."

Further studies are needed to identify a protein that attaches to this HUD element and regulates its function. Identifying that regulator, the scientists said, could open the door to ways to control plant growth and yield.

A short digital video is available at www.biology.ucsd.edu/scicomm/v … eo/bigbeansprout.mov that shows in time-lapse motion over several days the growth spurts of a soy bean plant just before dawn.

Provided by Oregon State University