Gene discovery suggests way to engineer fast-growing plants

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Switchgrass is being considered as feed stock for biofuels production, but it takes two years to reach harvest. | USDA via Wikimedia

(PhysOrg.com) -- Tinkering with a single gene may give perennial grasses more robust roots and speed up the timeline for creating biofuels, according to researchers at the Duke Institute for Genome Sciences & Policy (IGSP).

Perennial grasses, including switchgrass and miscanthus, are important biofuels crops and can be harvested repeatedly, just like lawn grass, said Philip Benfey, director of the IGSP Center for Systems Biology. But before that can happen, the root system needs time to get established.

"These biofuel crops usually can't be harvested until the second or third year," Benfey said. "A method to improve root growth could have a major role in reducing the time to harvest for warm season grasses."

Benfey's team appears to have found a way to do just that. They took a directed genomic approach aimed at identifying genes that become active when cells stop dividing and start taking on the characteristics of the mature, adult cell they are to become. "We systematically looked for those genes that come 'on' precisely when cells transition from proliferation to differentiation and then turn 'off' again just as quickly," Benfey said.

That genome-wide search in the roots of the familiar laboratory plant Arabidopsis and subsequent screening of mutant lines turned up a single gene, which the researchers call UPBEAT1 (UPB1). Further study showed that UPB1 controls the gene expression of enzymes known as peroxidases.

They then showed that these peroxidases control the balance of free radicals between the zone of cell proliferation and the zone of cell elongation where differentiation begins. (Although free radicals are probably most familiar as agents of stress to be combated with antioxidants, Benfey noted that the balance of free radicals has also been implicated in the control of a similar transition from proliferation to differentiation in animals.)

When the researchers experimentally disrupted UPB1 activity in the plant root, it altered the balance of free radicals such that cells delayed their differentiation and continued growing. Those plants ended up with faster-growing roots, having more and larger cells. When UPB1 activity was artificially increased, the growth of plant roots slowed.

"It's possible that by manipulating a single gene, you could get a plant

with rapid growth," Benfey said. Interestingly, UPB1 appears to act independently of plant hormones that play well-known roles in the balance between cell division and differentiation.

From an engineering perspective, the prospect of enhancing growth by taking a gene away, as opposed to adding one, is particularly appealing, Benfey notes.

"It also suggests that plants are not growing at their full potential," he says. That makes sense, of course, as plants in the real world have to make tradeoffs, for example, between growth and reproduction.

In addition to their potential in biofuels production, the findings might also lead to new ways to produce bigger and stronger plants with the capacity to sequester more earth-warming carbon dioxide from the atmosphere, Benfey says. His startup company, GrassRoots Biotechnology Inc., has acquired the patent for this discovery with its potential in mind. The company's primary goals are the development of next-generation biofuels and the use of root systems for carbon sequestration.

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