Cellulosic Biomass Study of *Miscanthus x giganteus* and the LI-6400

View on the Web

The use of blended fuels has become a nearly ubiquitous part of our everyday lives. Lately, however, ethanol production has come under increasing scrutiny; questions abound concerning the efficiency of corn ethanol as a renewable source of energy, the possibility of widespread deforestation for the purpose of creating tillable land, and the rising cost of food due to the diversion of grains from human or animal consumption into a fuel additive. Ethanol, however, can also be made from cellulosic biomass, which is abundant around the world, and is highly underutilized. Cellulosic ethanol has a number of advantages over ethanol derived from corn, including:

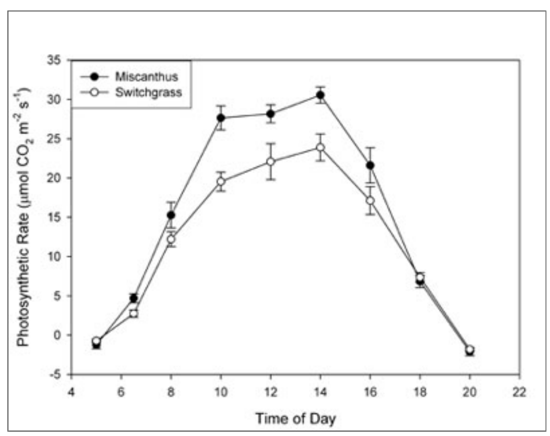

University of Illinois at Urbana-Champaign doctoral student Frank Dohleman uses the LI-6400 to make photosynthesis measurements in Miscanthus canopy.

1. Greater variety of materials can be used for potential conversion purposes,
2. Less fertilizer is required, and
3. Entire plant is used, not just the grain, so production per land area is greater, with fewer waste products.

An ambitious group of researchers at the University of Illinois at Urbana-Champaign believe they have found a plant with enormous potential as a biomass energy source in Miscanthus x giganteus, a sterile hybrid grass related to sugarcane. This group, led by Dr. Stephen P. Long, a professor of crop science and plant biology at the University of Illinois is currently conducting studies that aim to compare the productivity of Miscanthus with that of switchgrass and corn. One of Professor Long's doctoral students, Frank Dohleman, is using the LI-COR LI-6400 Portable Photosynthesis System to investigate how Miscanthus is so productive, particularly when compared to other C_4 plants like sorghum, corn, or switchgrass that are grown in Illinois.

This research is part of an effort to develop fuels from plant materials, funded by the Illinois Council for Food and Agricultural Research, which helped to provide a $500 million grant made by British Petroleum to the University of California at Berkeley, University of Illinois at Urbana-Champaign and Lawrence Berkeley National Laboratory. As part of the project, Dr. Long was named Deputy Director of the Energy Biosciences Institute.

The Miscanthus and switchgrass plots were planted in 2002, using a line of rhizomes originating at the Chicago Botanic Garden and donated by the Turfgrass Program at the University of Illinois at Urbana-Champaign. Preliminary results showed that Miscanthus had a roughly 27% greater rate of photosynthesis at midday when compared to switchgrass (see chart). After two years of switchgrass studies, the research now includes comparison of Miscanthus and corn. Diurnal measurements this year were made every other hour from sun-up to sunset on 14 days during the growing season. In addition to the LI-6400, Dohleman's group uses LI-COR's LI-3100 Area Meters after harvest to make destructive measurements of leaf area in order to measure total canopy leaf area.



Plot of diurnal photosynthetic rates of Miscanthus and Switchgrass.


LI-6400 Portable Photosynthesis System and Miscanthus leaf.

The ultimate goal of this research is to demonstrate its feasibility as a viable biofuel. Some hurdles still exist; the current cost of producing cellulosic ethanol is high, and propagating the sterile rhizomatous grass is very labor-intensive. There is reason for optimism; scientists expect that the cost of cellulosic ethanol production can be reduced to $1.07 per gallon by 2012. And a specialist in large scale production of transplants, Speedling, Incorporated (Sun City, FL, www.speedling.com) is currently involved in producing Miscanthus rhizomes on a commercial scale.

LI-COR is proud to have a small role in this groundbreaking research. See for yourself why the LI-6400 is the most widely referenced photosynthesis system in the world by visiting **http://www.licor.com/env/Products/li6400/6400XT.jsp**. In addition, you can see how the LI-6400 has been improved yet again, with the introduction of the new LI-6400XT System, which features a number of significant enhancements, including Ethernet connectivity, removeable data storage media, and bar code reader capability.

miscanthus x gianteus

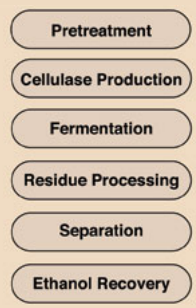
Giant Miscanthus is a sterile hybrid grass that grows up to 13-14' at maturation. Miscanthus x giganteus uses the C_4 photosynthetic pathway. Unlike sugarcane, sorghum, corn, and other C_4 plants, miscanthus exhibits high quantum yields of CO_2 assimilation while growing in cool to cold climates. This trait allows Miscanthus to achieve high efficiencies in converting light into biomass, and makes it an ideal candidate for cellulosic biomass production in more northerly climates.

Mature stand of Giant Miscanthus

Miscanthus x giganteus is a rhizomatous grass that thrives in untilled fields. Reaching maturity in 3-4 years, Miscanthus requires little water or fertilization, and competitively outgrows weeds, yet does not become invasive due to its slow rate of spreading. Leaves drop in the winter, leaving stems that can be harvested as late as spring. Fully grown plants can yield 10-30 tons per acre dry weight per year, more than double that of switchgrass. After harvesting, Miscanthus can be baled or pelletized for burning, or converted to cellulosic ethanol (one ton of Miscanthus could produce up to 80 gallons of cellulosic ethanol). Burning Miscanthus produces only as much CO_2 as has been removed from the air during the growing season, meaning it is carbon neutral, unlike fossil fuels.

What is Cellulosic Ethanol?

Ethanol is produced by fermentation of sugars. Additional sugars can be released from the breakdown of cellulosic fibers found in most plants. However, cellulosic biomass is more difficult to convert to ethanol due to the additional decomposition step. Advances in cellulases that break down the cellulose are currently promising and may lead to commercial scale cellulosic ethanol production in the near future.



Pretreatment - steam, or dilute sulfuric acid separates the biomass into cellulose, hemicellulose, and lignin.
Cellulase Production - cellulases produced naturally by fungi, microbes, or in the guts of termites are scaled up for commercial quantitites using bioreactors or cell cultures.
Fermentation - cellulase breaks down cellulose and hemicellulose into sugars, which are fermented using microbes of modified yeasts.
Separation - the sugar solution is separated from residual materials such as lignin.
Residue Processing - also known as Co-Product Processing, this process recovers CO_2 and distillers grains created during ethanol production. CO_2 can be used in carbonated beverages or used in dry ice. Wet distillers grains are commonly converted to cattle rations.
Ethanol Recovery - hydrolysis and fermentation of the sugars results in a dilute solution of ethanol, which is distilled and dried to make 100% pure ethanol.

For More Information

http://miscanthus.uiuc.edu/
http://miscanthus.uiuc.edu/index.php/ebi/
http://www.news.uiuc.edu/NEWS/05/0927miscanthus.html
http://en.wikipedia.org/wiki/Miscanthus