IOWA STATE UNIVERSITY

Plant Sciences Institute UPDATE

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Initiative aims for better beans through biotech

Mark Westgate says he knew years of breeding nearly identical soybean lines would pay off with insights into genes affecting seed composition. The lines are a key part of the Plant Sciences Institute's Nutrition Initiative.

New technologies, supported by the Plant Sciences Institute's Nutrition Research Initiative, will capitalize on more than a decade of Mark Westgate's soybean breeding research.

Westgate, an Iowa State agronomy professor, developed soybean lines that are 94 percent genetically identical, but produce beans with protein content varying from 30 percent to 42 percent by weight.

"I wanted to simplify the genetic basis for the variation so it becomes easier to understand what's going on at a molecular level," said Westgate, an affiliate of the Center for Designer Crops. Understanding the basis for variation, however, was more arduous before the advent of new biotech tools. Now, the soybean lines are a foundation for the Nutrition Initiative's feed component.

Basil Nikolau, director of the Center for Designer Crops and leader of the Nutrition Initiative, said Westgate's lines "absolutely give Iowa State an edge" in improving soybeans.

"That's the goal," Westgate said. "The market is a tough place, because it wants both high protein and high oil content in soybeans," he added. "Oh, and don't forget high yield."

Typically, beans bred for high protein have low oil, low yield, or both. Increasing oil usually means less protein, Westgate said. Because Westgate's soybean lines, developed with a University of Minnesota plant breeder, produce seed

CONTINUED ON PAGE 3

Meeting to tailor crops for biomass and bioenergy

Some people hope the Midwest might someday surpass the Mideast in energy production, but tapping that renewable energy is tougher than just drilling a well.

Lawrence Johnson, director of the Center for Crops Utilization Research, wants to change that. His center is gathering experts to kick-start efforts to make plant material better for conversion to energy and biobased products. "Tailoring Lignocellulosic Feedstocks for Bioenergy and Bioproducts" will meet May 16 at Iowa State's Memorial Union. It's part of the Plant Sciences Institute's Biorenewables Research Initiative and Iowa State's Bioeconomy Initiative.

Much of the energy in plants lies in biomass fiber made of lignin, hemicellulose and cellulose—the tough stuff that lets plants stand up, extend leaves and protect seeds. But lignocellulose is tough to break down into sugars for conversion into fuels and products, so biomass feedstock—corn stalks, soybean hulls, switchgrass, and even sawdust—is underutilized, Johnson said.

"We've devoted more than 30 years of research to conversion with minimal success," he said. "It seems to me we need to change the feedstock."

Panels will discuss the state of the art in conversion and opportunities for improvement; agronomic issues and plant breeding approaches; and biochemistry, molecular biology and chemical approaches.

Biomass boom?

Have we struck oil in Iowa? Is it boom time for biomass?

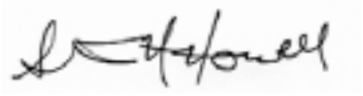
In a recent front-page article, the *Wall Street Journal* claims that the boom in biomass—converting corn to fuel—is revitalizing Midwest farm towns. About 15 percent of Iowa's 2004 corn crop was converted to ethanol. Iowa also broke all records last year, consuming more than a billion gallons of ethanol-blended fuel. Iowa's biofuel production stretches U.S. resources, but scarcely meets national fuel needs.

Using our feedstocks for fuel has created a new mindset throughout the agriculture community. For many years, Iowa crops have been bred for grain yield and feed quality. But other priorities arise if crops are grown for biomass. The goal of the Institute's new Biorenewables Research Initiative is tailoring feedstocks for bioenergy and biobased products.

A largely untapped source of biomass for bioenergy production is crop residue, such as corn stover. However, these crop residues are tough and stringy—difficult to brew into ethanol. A workshop scheduled for May 16 and sponsored by the institute's Biorenewable Initiative and by Iowa State's Bioeconomy Initiative will identify research projects to attack that problem. Of primary importance is finding ways to reduce the high costs of digesting lignocellulose, the major crop residue, to make products that can be fermented into fuel.

Biomass production also may mean transitioning to alternative crops. Switchgrass, a natural prairie grass, is a favorite for biomass production because it requires fewer inputs than corn and is well suited for soil conservation practices.

The biomass boom presents exciting new challenges for the Plant Sciences Institute and its Biorenewables Research Initiative.



Stephen Howell
Director

Steroids study could pump up plants

Like anabolic steroids that are much in the news lately—plants also produce steroids that make them bigger, heartier and healthier.

That's why scientists like Yanhai Yin, a new assistant professor of genetics, development and cell biology at Iowa State, are probing how plant steroids, called brassinosteroids, work.

Brassinosteroids, like human steroids, are essentially hormones, Yin said. Plants produce them to control major aspects of their own growth and development, including cell elongation, plant aging and stress resistance.

"Plants produce this hormone to promote their own development from seeds to mature plants," Yin said. "It's important for the whole development process."

Yin was a researcher in Professor Joanne Chory's group at the Salk Institute for Biological Studies in California before he joined Iowa State last fall. In a paper published in the January 28 issue of the journal *Cell*, the group described a key factor in how brassinosteroids work.

In humans, steroids act directly in the nucleus. In plants, they act on receptors on the cell surface. The mystery was how the hormone's chemical signal makes it from there to genes in the nucleus.

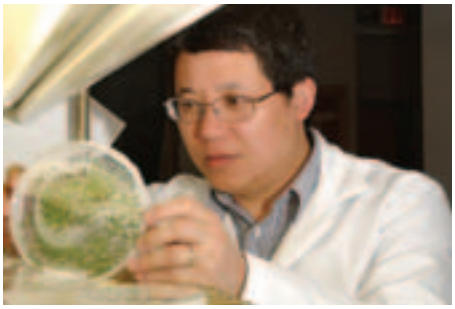
Previous Salk research found a protein called BR1 is the brassinosteroid receptor on the cell membrane. The *Cell* paper described how BES1, another protein, accumulates in cell nuclei due to steroid action. Researchers determined that BES1 binds to genes and activates them.

"It's like a switch," Yin said. Without the brassinosteroid, BES1 degrades in the cell. With the brassinosteroid, it accumulates and activates genes.

Because brassinosteroids are natural plant products that work differently than human steroids, there's no harm in consuming them, he said.

Now Yin uses BES1 as a marker to find its partners and the genes it targets. If he can determine how it interacts with those "partners" to control plant functions, scientists might be able to target individual functions.

"If we can separate two processes, like promoting cellular elongation but delaying plant aging, we could make a crop that has higher yield and produces vegetables or fruit that stay fresh longer," Yin said.



Genetics, development and cell biology assistant professor Yanhai Yin says two years of studying animal models gave him insights into plant steroid function.

'Plant stem cells' are symposium topic

What some call the plant equivalent of human stem cells will be the focus of the 2005 Plant Sciences Institute Symposium, June 2-5 in the Scheman Building in Ames.

"Meristems 2005" will bring together experts on "the control center for cell growth," horticulture associate professor David Hannapel said.

"Meristems are where cell proliferation and differentiation take place," said Hannapel, who heads the program committee. "It's also where cell signaling and coordination take place."

Much of that signaling is a mystery, Hannapel said. Sorting out the process could be important. "You could enhance growth and make the plant more vigorous."

Keynote speaker Thomas Laux, a researcher at the University of Freiburg in Germany, will compare plant to human stem cells. Around 180 researchers and students from around the country are expected to attend. For more information, go to www.bb.iastate.edu/~gfst/phomepg.html.

Course helps teachers buy into biotech

When experiments fail or projects take years, it's sometimes hard to see the impact of research, Jonathan Wendel says.

"But if you taught a good class, you at least felt you had an impact," Wendel added. That's one reason Wendel, chairman of the Department of Ecology, Evolution, and Organismal Biology likes the outreach component of his National Science Foundation (NSF) grant. Major NSF Plant Genome Program projects like Wendel's research on cotton genetics must demonstrate broader societal and scientific impact.

The outreach program, now in its third year, brings middle and high school science teachers to Ames for seven weeks each summer. Participants, who receive a stipend, learn lab protocols and research techniques, then work in labs under faculty mentors.

"Working with these teachers, there's satisfaction that you played some role in improving society," said Wendel, an affiliate of the Laurence H. Baker Center for Bioinformatics and Biological Statistics.

Besides learning cutting-edge science, teachers take home $500 for classroom materials. "We want to inspire them so when they go back to their classrooms they'll inspire their students," program director Adah Leshem-Ackerman said.

Maine middle school teacher Kathleen Hudson participated in a plant genome research outreach program in summer 2004 and worked in the Center for Plant Transformation with center director Kan Wang.

That's what happened to Kathleen Hudson, a 10-year middle school biology teaching veteran. Hudson was frustrated with the lack of time and support to upgrade her science expertise. The outreach program fit the bill.

"Intellectually and emotionally the experience was exactly what I needed to recharge myself," Hudson wrote in comments after the session.

The program is financed year-to-year. "We're trying to establish it as a fixed institution, so we're fund-raising big time," Leshem-Ackerman said.

Initiative aims for better beans through biotech/CONTINUED

with varying composition, they narrow the possible genes influencing composition to 6 percent of soybean genes.

That doesn't necessarily make it easy to identify the key genes. If there are about 40,000 soybean genes, 6 percent means about 2,400 differ.

Iowa State researchers will bring lots of high-tech tools to bear on the problem. Microarray technology—able to test for the expression of thousands of genes at once—will be used to identify key genes. Metabolic flux mapping will determine the metabolic basis for genetic and environmental variation in composition. Other researchers will look at micronutrients, like vitamins, isoflavones and flavenoids.

Once the key genes are identified, Westgate said, researchers can learn what governs the way seeds parcel out carbon and nitrogen resources. He added, "If we understand how these resources are allocated into each seed component, then we can begin to manipulate the processes that help the plant maximize protein and oil accumulation."

News Briefs

Find aids sugar studies

Iowa State researchers have discovered a new class of enzymes that simplifies the production of carbohydrate building blocks.

Plant Sciences Institute researcher and assistant professor of chemistry Nicola Pohl led the team. Pohl also recently was named an Alfred P. Sloan Research Fellow, earning a $45,000 two-year grant.

In research published in the *Journal of the American Chemical Society*, Pohl's group discovered the enzymes, produced from genes found in deep-sea microbes that grow at high temperatures. The enzymes have a special property: They interact with numerous substrates to create many different sugars.

The enzymes from the deep-sea organisms were better at making a range of carbohydrate building blocks than enzymes from yeast and the bacteria *E. coli*.

Grant probes pest proteins

Iowa State researchers will use new proteomic tools to examine how soybean cyst nematodes infect bean roots under a $900,000, three-year grant from the U.S. Department of Agriculture.

Plant pathology associate professor Thomas Baum said the long-term goal is to block the parasites from infecting plants. The research team, which includes statistics associate professor Dan Nettleton and scientists at the universities of Georgia, North Carolina State and Missouri, has traced more than 50 proteins nematodes use to invade soybean plant cells. Now they'll track the proteins' action at the molecular level.

Student swap set

Iowa State graduate students soon will participate in a new exchange program in biorenewable resources.

The program, financed by the U.S. Department of Education, will exchange three students from each of three universities—Iowa State, Arkansas and Washington at Seattle—with the universities of Graz in Austria and Ghent in Belgium, and to the Polytechnic Institute of Toulouse, France, said Lawrence Johnson, director of the Center for Crops Utilization Research. The three-year program starts with a two-week course April 10-23 in Toulouse.

Recent research grants

The following 26 new grants totaling $6.1 million were awarded recently to plant science researchers at Iowa State.

Center for Catalysis
Department of Energy — $982,000
(G. Kraus, chemistry)

Application of Biotechnology to Control of the Soybean Cyst Nematode
United Soybean Board — $779,400
(T. Baum, plant pathology)

Functional Analyses of Genes Involved in Leaf Initiation
National Science Foundation — $569,978
(P. Schnable, agronomy)

Nutritional Intervention for Older Adult Muscle Loss (Phase II)
Metabolic Technologies Incorporated — $374,982
(P. Flakoll, food science and human nutrition)

Single Molecule Immunoassay and DNA Screening
National Institutes of Health — $302,178
(E. Yeung, chemistry)

Functional Genomics of Soybean Seed Composition
Consortium for Plant Biotechnology Research, Inc. — $165,775
(B. Nikolau, biochemistry, biophysics and molecular biology)

Breeding General-Use and Specialty Soybeans for Iowa
Iowa Soybean Promotion Board — $150,000
(W. Fehr, agronomy)

Development of Maturity I-IV Varieties for the Better Bean Initiative
United Soybean Board — $119,300
(W. Fehr, agronomy)

High Beta-Carotene Maize to Alleviate Vitamin A Deficiency in Sub-Saharan Africa
The Centro Internacional De Agricultura Tropical (CIAT) — $75,000
(S. Rodermel, genetics, development and cell biology)

Genetic Improvement of Soybean for Disease Resistance
Iowa Soybean Promotion Board — $67,591
(M. Bhattacharyya, agronomy)

Legume Information System
National Center for Genome Resources — $65,994
(V. Brendel, genetics, development and cell biology)

Soybean Transformation Program at Iowa State University
Iowa Soybean Promotion Board — $57,687
(K. Wang, agronomy)

Translational Genomics to Decipher Resistance Signaling Pathways
USDA — $52,000
(S. Whitham, plant pathology)

Non-host Resistance for Engineering Disease Resistance in Soybean
Iowa Soybean Promotion Board — $42,884
(M. Bhattacharyya, agronomy)

Soybean Molecular Marker Facility
Iowa Soybean Promotion Board — $32,775
(M. Bhattacharyya, agronomy)

Granular Development and Value-Added Utilization of Gem Line Starch
USDA — $31,250
(J. Jane, food science and human nutrition)

Mapping the sgRNA2 and sgRNA3 Promoters of BYDV
National Institutes of Health — $29,751
(W. Miller, plant pathology)

Functional Genomics of Arabidopsis Starch Granule Metabolism
National Science Foundation — $495,300
(A. Myers, biochemistry, biophysics and molecular biology)

Aphid Resistance in Plants Mediated by Luteovirus Structural Proteins and an Intrahemocoelic Toxin
USDA — $350,000
(W. Miller, plant pathology)

Advanced Biorefinery Feedstocks
Metabolix Inc. — $240,000
(E. Wurtele, genetics, development and cell biology)

Risk and Benefit Analysis for Genetically Modified Agricultural Products
USDA — $178,000
(M. Misra, agricultural and biosystems engineering)

Functional Analysis of Plant MAPK Cascades in Stress and Hormonal Signaling
National Science Foundation — $112,044
(K. Wang, agronomy)

Basement Membranes, Baculovirus Dissemination and the Insect Immune Response
USDA — $85,000
(B. Bonning, entomology)

Uniformity in Near Infrared Measurements of Soybean Quality Traits
American Oil Chemists Society — $53,690
(C. Hurburgh, agricultural and biosystems engineering)

Development of a Novel Fermentation Process for the Anaerobic Conversion of Glycerol and Co2 into Succinic Acid Using Escherichia
USDA — $365,000
(R. Gonzalez, chemical engineering)

Role of Apoplastic Water Potential Modulation in Plant Defense
USDA — $342,372
(G. Beattie, plant pathology)

Plant Sciences Institute UPDATE

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The Plant Sciences Institute at Iowa State University is dedicated to becoming one of the world's leading plant science research institutes. More than 200 faculty largely from the College of Agriculture, the College of Liberal Arts and Sciences, the College of Family and Consumer Sciences, and the College of Engineering conduct research in nine centers of the institute. They seek fundamental knowledge about plant systems to help feed the growing world population, strengthen human health and nutrition, improve crop quality and yield, foster environmental sustainability and expand the uses of plants for biobased products and bioenergy. The Plant Sciences Institute supports the training of students for exciting career opportunities and promotes new technologies to aid in the economic development of agriculture and industry throughout the state. The institute is supported through public and private funding.

To be added to our mail list, e-mail psidir@iastate.edu.

On the Web at www.plantsciences.iastate.edu/

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