

Plant Sciences Institute UPDATE

Molecular mechanism of soybean rust probed

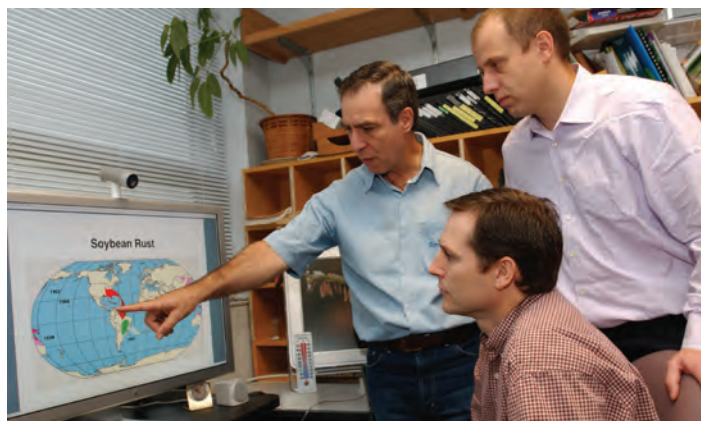
A long-anticipated—and feared—soybean fungus finally has arrived in the United States, but Plant Sciences Institute researchers already are seeking biotech-based ways to block it.

Iowa State plant pathology faculty members Thomas Baum and Steve Whitham are studying how Asian soybean rust affects plants at the gene expression level. Their project is the centerpiece for the Crop Protection Initiative, one of five research initiatives recently implemented by the Plant Sciences Institute.

The rust fungus, found in the southern United States for the first time last fall, makes soybean plants shed their leaves prematurely, cutting yields by as much as 80 percent. Fungicide sprays offer control, but they significantly raise the cost of soybean production. Experts believe rust could appear in Iowa as soon as this summer.

Other researchers have largely studied the fungus' spread. "They deal with the imminent problems and the crisis as it unfolds," said Baum, director of the Center for Plant Responses to Environmental Stresses. He and Whitham, professor-in-charge of Iowa State's DNA gene chip facility, are focusing on a long-term solution: Rust's interaction with soybean genes. "If we can piece together a story there ... we can devise strategies to stop the fungus," Baum said.

The Iowa State researchers are collaborating with EMBRAPA Soja, the Brazilian equivalent of the U.S. Department of



Alvaro Almeida, left, researcher for the Brazilian agency EMBRAPA Soja, discusses spread of rust with Iowa State faculty members Thomas Baum, right, and Steve Whitham. Almeida visited Ames last fall as part of a joint project to study plant responses to rust fungus infection.

Agriculture Agricultural Research Service. Alvaro Almeida, the agency's rust research leader, visited Iowa State last fall to discuss his country's control strategies.

Iowa State and Brazilian researchers will work in Brazilian greenhouses to study rust's progress in infected soybeans. An Iowa State researcher will work with the Brazilians to extract soybean RNA, the product of gene expression, from infected and uninfected plants. Iowa State's DNA gene chip facility will use the RNA to scan through 33,000 genes in the soybean genome, seeking ones that are activated or inactivated by rust infection.

The fungus progresses more slowly in some soybean varieties than in others, Baum said, and different fungus strains behave

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Rust could appear in Iowa as soon as this summer.



Biotech birthday

This year marks a quarter century since the development of the first transgenic or “biotech” plants. The technology has been a phenomenal success.



In 2004, 85 percent of the soybeans and 46 percent of the corn planted in the United States were biotech crops. A recent study by C. Ford Runge at the

University of Minnesota found Iowa has reaped higher value from biotech crops than any other state. Runge also is quoted as saying, “Those [states] that have aggressively adopted and invested in biotechnology are reaping the greatest rewards.”

Despite these successes, only a few biotech products have made it to the marketplace—although those that did have been widely adopted. Still, it has become tougher to move new biotech crops into the marketplace, and most present-day products represent technologies that are more than a decade old. That’s because regulatory and commercialization obstacles have clogged the adoption pipeline.

Through its research initiatives, the Plant Sciences Institute is working to develop all kinds of exciting biotech products of potentially great value to the marketplace. They include soybeans that produce “ready-made” biodiesel and corn that makes a “weight watching” starch. These products will be of little benefit to producers and consumers if they languish in the regulatory pipeline or face huge costs to commercialize.

A few states have faced ballot measures that would add to the regulatory burden or ban biotech crops outright. Iowa should not fall victim to such measures, because the biggest losers are those who benefit most from biotech crops—and Iowa would top the list.

Stephen Howell
Director

Better bacteria through biotech probed

Ramon Gonzalez wants more bang from a bacterium. The Iowa State assistant professor of chemical engineering uses biotechnology tools in an effort to make *E. coli* more efficient in converting plant material into ethanol and other useful chemicals.

“We try to take advantage of all the technologies and tools developed during the era of genome sequencing,” said Gonzalez, an affiliate of the Center for Crops Utilization Research. “We incorporate that into our approach to metabolic engineering.”

Metabolic engineers use genetic engineering techniques to modify or redirect biochemical pathways. The goal is to coax bacteria into making new chemicals or larger quantities of products they already generate.

Gonzalez and his research group focus on *E. coli* and its ability to convert sugars to ethanol. Unlike other organisms used to make ethanol, such as yeast, *E. coli* converts all the sugars in plant biomass to ethanol, but it’s inefficient, Gonzalez

said. It first rapidly metabolizes glucose, a sugar with six carbon atoms, but it converts five-carbon sugars (such as xylose and arabinose) more slowly. The result: long fermentation times and some residual five-carbon sugars.

The researchers use biotech tools, such as gene expression, protein and metabolite analysis, to identify desirable genes and metabolically engineer *E. coli* so it efficiently ferments sugar mixtures into fuels and chemicals.

“That’s the goal—to let the bugs guide you to the useful genes,” Gonzalez said. “People thought this way before, but they didn’t have the tools.” His group wants to use microorganisms to efficiently convert sugars to other substances, too, including organic acids and vitamins.



Ramon Gonzalez
engineers better
bacteria.

Experts advise incubator businesses

Companies in the Plant Sciences Institute business incubator have a new resource for advice and guidance.

Six industry leaders are available to mentor companies in the Innovations Development Facility at the Roy J. Carver Co-Laboratory. Facility director Cheryl Kamman said the mentoring group will help keep companies moving in the right commercial direction.

“Mentors will help us accelerate the commercialization process,” Kamman said. Each company can choose two or three mentors and meet with them at least quarterly. Mentors will act as helpful “gatekeepers,” assisting companies establish and meet specific milestones, providing invaluable market information and industry

contacts, and recommending ideas for the next step.

The mentors are: Keith Barnes, recently retired president and chief executive officer of Proliant, Inc.; Ted Crosbie, vice president of Global Plant Breeding for the agricultural sector of Monsanto Co.; John Greaves, president of Kemin AgriFoods North America, Inc.; David Hettinga, chief executive officer and chairman of the board of Thermo Solutions, Inc.; Rick McConnell, recently retired president of Pioneer Hi-Bred International, Inc.; and Jack Staloch, president of Cargill Acidulants.

Executives in the plant science or life science industries who are interested in mentoring can contact Kamman at 515 294-3945 or kamman@iastate.edu.

Molecular mechanism of soybean rust probed/CONTINUED

differently in any given soybean variety. That will make it difficult to stop the disease at the molecular level. “We need to find a common denominator, something that all soybean rust fungus strains do to ward them off,” Baum said. It’s an opportune time for such research, he added.

“We have a place to conduct the research and a high-powered DNA gene chip facility at our disposal,” Baum said. “At least, we should be able to contribute to a greater understanding of the disease.”

News Briefs

Group advises center

A new advisory board will give industry, farmers and government the opportunity for input into the Center for Crops Utilization Research.

The 10-member panel will meet at least yearly to provide planning advice, develop key action items for the center, and make recommendations it sees as important to the center's effectiveness, director Larry Johnson said. Membership includes industry and commodity group representatives, farmers and an Iowa Department of Economic Development official.

"Our center ... has to be concerned about how the science and technology we use can be converted into economic development activity and be of value to our stakeholders," Johnson said

Jeff Stroburg, chief executive officer of West Central Cooperative in Ralston, Iowa, chairs the board.

Chem E-plant link touted

Chemical engineers should be more involved in plant research, an Iowa State professor argues in the January issue of the *AIChE Journal*, the journal of the American Institute of Chemical Engineers.

Chemical engineering professor Jacqueline V. Shanks, a member of the Plant Sciences Institute Council, writes that engineers can advance plant science by studying and controlling chemical reactions in plants.

"Clearly, plant scientists and chemical engineers have complementary expertises, but since there are so few chemical engineers in such collaborations, the dialog has been limited and needs to be fostered," she adds.

Biosafety meeting set

Biosafety regulations and policies governing the movement of genetically modified products will be the subject of a symposium April 19 and 20 in Ames.

The Biosafety Institute for Genetically Modified Agricultural Products (BIGMAP) and the Plant Sciences Institute are sponsoring the second annual biosafety symposium at the Hotel at Gateway Center.

The event includes a special workshop on containment strategies for plant-made pharmaceuticals and industrials.

Barley database holds promise for plants

With a mouse click, Roger Wise and other researchers now can find in seconds information that might have taken hours to locate in lab notebooks.

Wise, a U.S. Department of Agriculture researcher affiliated with the

producing chips for plants, Wise said. The barley chip's success—more than 1,800 have been distributed since June 2003—prompted the company to underwrite development of chips for other plants, including soybean, wheat, grape and rice.



Iowa State researchers Lishuang Shen, left, Julie Dickerson, Dan Nettleton, and USDA researcher Roger Wise discuss applications of BarleyBase, the online gene expression database established at Iowa State.

Center for Plant Responses to Environmental Stresses, just taps into BarleyBase, a gene expression database he and other Iowa State scientists established for barley and other plants.

The database, online since fall 2003, sprang from a drive by Wise, scientists from four other American universities, and international collaborators to develop the Barley1 GeneChip®. The chip can detect the expression of 22,000 cereal grain genes in a single experiment.

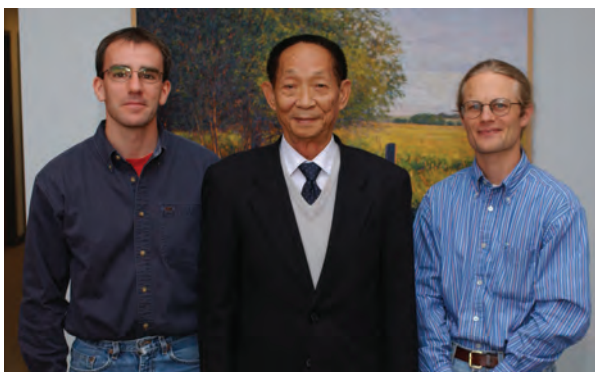
At the time, GeneChip® maker Affymetrix had little interest in mass-

"That's the added impact on several plants, especially minor crops lacking a completed DNA sequence," Wise said.

Wise; electrical and computer engineering associate professor Julie Dickerson; genetics, development and cell biology professor Volker Brendel; and statistics associate professors Dan Nettleton and Di Cook later got funding for BarleyBase. Dickerson and postdoctoral researcher Lishuang Shen designed the

database and web-accessible analysis tools. In about a year, it has grown to include results from more than 1,000 GeneChips® worldwide.

BarleyBase is interlinked with other databases, letting researchers cross-reference information about other plants. Dickerson said the software is usable for any kind of GeneChip® data, including animal genes. The researchers now are seeking financing for PLEXdb—a plant expression database covering many species.



World Food Prize laureate visits

Yuan Longping, center, Director-General of the China National Hybrid Rice Research and Development Center and 2004 World Food Prize laureate, meets with Iowa State faculty

members Adam Bogdanove, left, plant pathology, and Jean-Luc Jannink, agronomy, during his visit to the Plant Sciences Institute on October 12, 2004.

Recent research grants

The following 26 new grants totaling \$9.6 million were awarded recently to plant science researchers at Iowa State.

Plant Biotechnology—Iowa: Technologies to Recover Recombinant Proteins from Plants for Use as Therapeutics and Industrial Enzymes

USDA—\$207,085

(L. Johnson, food science and human nutrition)

Visual Data Extraction and Conversion Programming Tool

National Institutes of Health—\$200,515

(H. Chou, genetics, development and cell biology)

Biotechnology Test Production: Technologies to Purify Recombinant Proteins from Plants for Use as Therapeutics and Industrial Enzymes

USDA—\$166,225

(C. Glatz, chemical engineering)

Functional Analysis of Virus and Host Components that Mediate Potyvirus-Induced Diseases

Binational Agricultural Research and Development Fund (BARD)—\$160,000

(S. Whitham, plant pathology)

Regulation of Shoot Development in Arabidopsis

National Science Foundation—\$135,955

(S. Howell, genetics, development and cell biology)

The Role of Starch in Nectar Production

National Science Foundation—\$135,000

(R. Thornburg, biochemistry, biophysics and molecular biology)

The Genetics of Genetics: Genes Controlling Recombination in Maize

National Science Foundation—\$99,999

(P. Schnable, agronomy)

Development and Implementation of a Grower Education Program for Identity-Preserved Production of 1% Linolenic

United Soybean Board—\$76,634

(W. Fehr, agronomy)

Engineering Carbohydrate Polymers for Value-Added Products from Agricultural Feedstocks

Petroleum Research Fund, American Chemical Society—\$40,000

(N. Pohl, chemistry)

Xanthomonas Pathovars Enabling a Broad Comparative Genomics Approach to Understanding Vascular and Non-Vascular Bacterial Diseases of Dicots and Monocots

USDA—\$684,500

(A. Bogdanove, plant pathology)

Functional Genomics of the Biotin Metabolic Network of Arabidopsis

National Science Foundation—\$379,996

(B. Nikolau, biochemistry, biophysics and molecular biology)

B-glucan Mediated Impacts of Genotype and Processing on Oat Nutritional and Sensory Function

USDA—\$360,000

(P. White, food science and human nutrition)

A Rice Oligo Chip and Identification of Genes Expressed During the Cereal Defense Response

National Science Foundation—\$179,087

(P. Schnable, agronomy)

NIH-NSF Bioengineering and Bioinformatics Summer Institute in Bioinformatics and Computational Biology

National Science Foundation—\$158,379

(V. Brendel, genetics, development and cell biology)

Soy Isoflavones and Cardiovascular Disease Risk

American Heart Association—\$60,496

(M. Reddy, food science and human nutrition)

Biodegradation of Transgenic Crop Residue

USDA—\$47,560

(J. Coats, entomology)

IGERT: Computational Molecular Biology Training Group

National Science Foundation—\$38,880

(D. Voytas, genetics, development and cell biology)

Iowa Biotechnology Consortium

USDA—\$1,671,538

(R. Brown, mechanical engineering)

Establishment of Robust Maize Transformation Systems for the Public

National Science Foundation—\$826,693

(K. Wang, agronomy)

Gasification of Switchgrass

Department of Energy—\$736,000

(R. Brown, mechanical engineering)

Center for Designing Foods to Improve Nutrition (CDFIN)

USDA—\$611,969

(P. Flakoll, food science and human nutrition)

Efficient Representation and Manipulation of Large-Scale Biological Sequence Data

National Science Foundation—\$440,494

(S. Aluru, electrical and computer engineering)

Development of a Catalyst/Sorbent for Methane Reforming

Department of Energy—\$129,498

(B. Shanks, chemical engineering)

Testing a Stakeholder Participation Framework that Enhances Acceptance of Bioremediation Technologies

Department of Energy—\$109,614

(R. Anex, agricultural and biosystems engineering)

High Beta-Carotene Maize to Alleviate Vitamin A Deficiency in Sub-Saharan Africa

International Center for Tropical Agriculture—\$75,000

(W. White, food science and human nutrition)

Biocomplexity in the Bioeconomy: The Natural and Industrial Ecology of Biobased Products

National Science Foundation—\$1,850,694

(R. Anex, agricultural and biosystems engineering)

Plant Sciences Institute UPDATE

The Plant Sciences Institute Update is published four times each year by the Plant Sciences Institute at Iowa State University, 1060 Roy J. Carver Co-Laboratory, Ames, Iowa 50011-3650; phone 515 294-5255.

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 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 <http://www.plantsciences.iastate.edu/>



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