IOWA STATE UNIVERSITY

Plant Sciences Institute UPDATE

October 2005, Volume 6, Number 1

Brazilian connection yields RNA for rust research

Iowa State researcher Martijn van de Mortel stands with soybean plants in an EMBRAPA Soja greenhouse in Brazil. Plants were covered with bags after some were inoculated with soybean rust spores and some were sprayed with plain water as a control.

Martijn van de Mortel's "commute" is longer than most. Van de Mortel, a postdoctoral researcher in Iowa State's plant pathology department, traveled to Brazil twice this summer. His trips will help researchers learn how soybean plants respond to rust infection at the molecular level.

Rust, a fungus that invaded South America a few years ago and appeared in the southern United States last fall, makes soybean plants shed leaves prematurely, cutting yields by as much as 80 percent. It was expected to strike Iowa and the Midwest this summer, but it hasn't arrived.

"Disease spread has been very favorable for Iowa so far, but it is too early to let our guard down because the next years can be very different," said Thomas Baum, director of the Center for Plant Responses to Environmental Stresses. Baum hopes his team's research will lead to soybean varieties that are resistant to rust. The project is the centerpiece of the Plant Sciences Institute's Crop Protection Initiative.

Van de Mortel traveled to Londrina, Brazil, to work in the greenhouses and labs of EMBRAPA Soja, the Brazilian equivalent of the U.S. Department of Agriculture Agricultural Research Service. "EMBRAPA selected the soybean lines we used. They have the rust fungus and they have the know-how to inoculate plants with it," van de Mortel said.

Researchers raised two sets of plants: a susceptible variety and a variety in which the disease progresses slowly. Researchers sprayed one-half of the plants from each variety with water containing rust spores. They sprayed the other half of the plants with plain water as a control.

Van de Mortel sampled leaf tissue and extracted RNA, the product of gene expression, from it. The RNA gives a "snapshot" of what genes are active or inactive at a given time.

"What we're hoping is that there is a set of genes that turns on early in infection and sets up all the genetic effects after that," said Steven Whitham, assistant professor of plant pathology. Sampling leaves over time will give a comprehensive picture of the disease's effects on the activities of soybean genes, he said.

The experiment was conducted in

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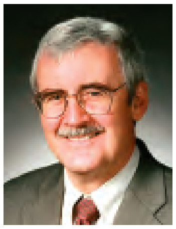
Greenhouse ribbon cutting

Iowa State President Gregory Geoffroy and Provost Benjamin Allen will be on hand at noon on October 19 for a ribbon-cutting ceremony at a greenhouse addition to the Roy J. Carver Co-Laboratory. The greenhouse is designed as a high-containment facility for transgenic plant material.

Iowa in transition

The *Des Moines Register* published a series of articles this summer about the transition in land ownership and the consolidation of Iowa agriculture. The stories were poignant, and it is always hard to accept change. However, there is room for optimism. These transitions may revitalize agriculture in Iowa as young people who are more diverse, and perhaps hold a different world view, become the next generation of farmers.

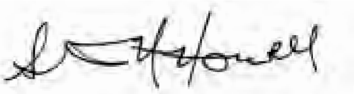


A major issue in consolidation is placing food security, land stewardship and the opportunity to profit from agriculture in the hands of a few. Economies of scale drive consolidation, but market forces cannot operate alone to safeguard Iowa's rich agricultural resource. One of the major trade-offs for consolidation is added government oversight to guarantee that these transitions benefit agriculture and the agricultural community. The new farm bill should ensure that this happens.

These transitions also should be viewed as an opportunity to promote the infusion of science into agriculture. However, many innovations and improvements are stalled in the technology pipeline. These technologies could improve agricultural practices by reducing the load of pesticides and herbicides and by using the land more efficiently. The next generation of well-educated and highly skilled agriculturalists may demand more accelerated application of these technologies.

The adoption of scientific advances is our best hope to maintain leadership in a global market and support the increasing need for raw materials to produce bioenergy and biobased products.

Iowa truly is in transition. Let's be sure that these transitions lead us to a better place.



Stephen Howell
Director

Discovered gene keeps corn in line

Erik Vollbrecht discovered a gene that played a key role in the improvement of corn.

An Illinois farmer's decision to save an unusual ear of corn in 1909 led a new faculty member in genetics, development and cell biology to identify a gene that's key for efficient corn production.

The gene that was lacking in the bizarrely shaped cob is vital to producing straight rows and compact ears, said Erik Vollbrecht, an affiliate of the Center for Plant Transformation. His research found that the gene—called ramosa1—is conserved in every modern corn variety. That's unusual for corn, a plant noted for its genetic diversity, Vollbrecht said.

If ramosa1 isn't present or is less active, corn ears develop with crooked rows or branched cobs, he said.

Vollbrecht was working as a postdoctoral researcher at the Cold Spring Harbor Laboratory in New York state when he and lead researcher Robert Martienssen isolated the gene. Their paper was featured on the cover of the August 25 issue of *Nature*, one of the most prestigious journals in science.

Ancient farmers who bred the wild grass teosinte into domesticated corn selected for ramosa1 by choosing ears with compact cobs and straight rows, Vollbrecht said. They found those ears packed in the most grain. "It's a matter of yield, a matter of packing efficiency," he added.

The researchers found nearly identical DNA sequences for ramosa1 in 40 unique corn varieties. They also found that plants in which the gene's effect was reduced produced ears with less straight rows. Grasses like rice and sorghum have more, longer branches because ramosa1 isn't present or isn't as active, Vollbrecht said.

Discovery of the gene may have implications for improving corn and other grains. Ramosa1 also influences tassel branch production. It takes only a few tassel branches to produce more than enough pollen, Vollbrecht said, and corn bred to produce fewer tassel branches can devote more resources to producing grain. Rice and other grains also might be made to produce more compact, better-yielding ears.

New associate director, congressman meet

Dr. Patrick Schnable, recently appointed Plant Sciences Institute associate director, shows U.S. Rep. Tom Latham of Iowa, left, through the Center for Plant Genomics. Latham, whose family has a seed company, visited the center and the Innovations Development Facility on August 9. Schnable's new duties include overseeing the institute's five research initiatives.

Researcher ponders plant recycling process

Learning how and why plants recycle cell structures and nutrients could give clues to making them produce more and better food, Diane Bassham says.

Bassham, an assistant professor of genetics, development and cell biology, studies autophagy—literally, "self-eating." Plants induce this process in senescence—cell aging—and to survive when stressed or starving.

Bassham, an affiliate of the Center for Plant Responses to Environmental Stresses, focuses on the vacuole's role in autophagy. Under normal conditions, the vacuole breaks down and stores cell materials. But during autophagy, "It's breaking down perfectly good parts of the cell … just so the cell can stay alive," she said.

With a $375,000 National Science Foundation grant, Bassham will study the cytoskeleton's role in autophagy. The cytoskeleton is a series of protein fibers that give the cell structure and transport materials through it.

"Our hypothesis is that the cytoskeleton is transporting materials to the vacuole," Bassham said. She and her team will look at what happens if parts of the cytoskeleton are prevented from recycling. The goal is to make plants more resistant to stress and to delay senescence, thereby increasing yield.

Genetics, development and cell biology assistant professor Diane Bassham has identified a gene required for autophagy, in which plant cells recycle nutrients and other materials.

Bassham also recently received a Plant Sciences Institute Grant of $30,000 per year for two years to focus on soybean proteins. "There, we're trying to do the opposite," she said, "package proteins so they won't be broken down in the vacuole." That's important if soybeans are genetically engineered to produce useful proteins, like drugs. The plant cell might attempt to recycle the proteins because they're foreign, Bassham said.

Biotech corn test secured

Workers and volunteers installed an eight-foot fence around plots of biopharmaceutical corn planted at the Iowa Army Ammunition Plant near Middletown.

Iowa State officials and researchers say they've successfully conducted a field test of biopharmaceutical corn.

The project was carried out in the confines of the Iowa Army Ammunition Plant near Middletown, in southeast Iowa, where two small plots were sown with genetically engineered corn.

Kan Wang, director of the Center for Plant Transformation, is conducting the research. The corn produces a protein that may stimulate immunity to diarrhea-causing bacteria in livestock, thus reducing antibiotic use. The corn will be used in animal feeding studies and to analyze efficient methods to extract and purify the protein.

To prevent crossing with conventional corn, the biopharmaceutical plants were planted later than commercial fields. Also, plants were hand-pollinated; the plots were 1.2 miles from the nearest commercial field; guards regularly checked the site; an 8-foot fence discouraged wildlife; and surveillance cameras monitored the plots.

"To ensure that people were comfortable with the experiment, the university implemented extra safeguards that exceeded federal regulatory requirements," said Beryl Packer, biosafety specialist for Iowa State. "Federal and state inspectors have reacted positively to how we've handled the research."

That's important for the future of Iowa's biopharmaceutical industry, said Wendy Wintersteen, interim agriculture dean: "If Iowa is going to realize the potential of growing these crops, then the research must demonstrate that it can be done in a way that doesn't threaten the commodity grain trade here or in neighboring states."

Brazilian connection yields RNA for rust research/CONTINUED

Brazil, where rust already is prevalent, to prevent the introduction of spores in the United States. The RNA samples van de Mortel brings from Brazil aren't infectious.

The researchers will use Iowa State's gene chip facility to analyze the samples for gene expression. Each chip tests for the activity of about 33,000 soybean genes. The rust research will use 120 of the chips, creating huge amounts of data for the scientists to sort.

"That probably is the most challenging aspect of the project," Whitham said. "There's a steep learning curve when you start analyzing data for 33,000 genes." Nonetheless, Whitham hopes the team will have some early results next spring.

Recent research grants

The following 26 new grants totaling $7.94 million were awarded recently to plant science researchers at Iowa State.

Agricultural Policy Harmonization Project
USDA—$792,201
(J. Cortes, seed science center)

International Competitiveness and Marketability of Midwest Agribusiness Products
USDA—$571,333
(B. Babcock, economics)

NASA Food Technology Commercial Space Center
National Aeronautics and Space Administration—$400,000
(A. Pometto III, food science and human nutrition)

Functional Genomics of Soybean Response to Cyst Nematode Parasitism Proteins
USDA—$300,000
(T. Baum, plant pathology)

Coupled Biological and Mathematical Models of Neuronal Pattern Formation
National Institutes of Health—$285,586
(M. Nilsen-Hamilton, biochemistry, biophysics and molecular biology)

Rice as a Model System for Investigating Diterpene Synthases
USDA—$232,000
(R. Peters, biochemistry, biophysics and molecular biology)

Design of Nanostructured Organic-Inorganic Hybrid Catalysts for Biorenewable Conversion
National Science Foundation—$102,730
(B. Shanks, chemical engineering)

Database of Maize Genome Information
USDA—$70,000
(V. Brendel, genetics, development and cell biology)

Fundamentals of Operation at Low S/O Ratios for Styrene Catalysts
CRI Catalyst Company—$50,000
(B. Shanks, chemical engineering)

Biodegradation of Transgenic Crop Residue
USDA—$47,560
(J. Coats, entomology)

Conjugation of Soybean Oil for Use as Ink and Alkyd Resin-Drying Oils
United Soybean Board—$38,500
(J. Verkade, chemistry)

ISGA: Functional Genomics of Plant Disease Defense Pathways
National Science Foundation—$548,380
(R. Wise, plant pathology)

The Function of Subtilase Genes in Plant Development
National Science Foundation—$280,770
(S. Howell, genetics, development and cell biology)

Metabolic Engineering of E. coli Sugar Utilization Regulatory Systems for the Consumption of Plant Biomass Sugars
National Science Foundation—$195,596
(R. Gonzalez, chemical engineering)

The Role of Starch in Nectar Production
National Science Foundation—$135,000
(R. Thornburg, biochemistry, biophysics and molecular biology)

Essential Nature of Fatty Acid Elongation in Plant Development
National Science Foundation—$130,000
(P. Schnable, agronomy)

Comparative Evolutionary Genomics of Cotton
National Science Foundation—$73,500
(J. Wendel, ecology, evolution and organismal biology)

Deciphering – 1 Frameshifting Cis Acting Domains in BYDV
National Institutes of Health—$49,928
(W. A. Miller, plant pathology)

New Technologies for the Production of High Value Chemicals from Glycerin
West Central Cooperative—$30,000
(G. Kraus, chemistry)

Malnutrition in Dialysis Patients
Department of Health and Human Services—$25,000
(P. Flakoll, food science and human nutrition)

VCA – A High-Density Genetic Map of Maize Transcripts
National Science Foundation—$1,304,309
(P. Schnable, agronomy)

IGERT: Computational Molecular Biology Training Group
National Science Foundation—$588,144
(D. Voytas, genetics, development and cell biology)

Bone Response to Soy Isoflavones in Women
National Institutes of Health—$496,157
(L. Alekel, food science and human nutrition)

A Highly Efficient Homologous Recombination System for Plants
National Science Foundation—$463,267
(D. Voytas, genetics, development and cell biology)

Cytoskeleton Function and Dynamics During Plant Vacuolar Autophagy in Response to Environmental Stresses
National Science Foundation—$375,000
(D. Bassham, genetics, development and cell biology)

Gene Expression in Polyploid Cotton
USDA—$360,000
(J. Wendel, ecology, evolution and organismal biology)

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 largely from the College of Agriculture, the College of Liberal Arts and Sciences, the College of Human 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.

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