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Growing, Together

For more than 30 years, Mizzou plant scientists have set the standard for cooperative research. Their Interdisciplinary Plant Group has brought expert faculty and million-dollar grants to campus, and it has been imitated around the world. STORY BY ERIK POTTER ✤ PHOTOS BY NICHOLAS BENNER

Doug Randall shakes his head when he thinks about professors at other top-flight universities who won't admit anyone from a rival colleague's lab into their own lab.

"I've been at institutions — very prestigious places — where faculty say: 'Don't let any of your students cross my threshold. I don't ever want to see them in my laboratory.' That doesn't exist here in the plant biology world," he says. "I just don't believe it's the right way to go."

In the mid-1970s, an effort to foster and preserve a far different culture at Mizzou led Randall and a half-dozen colleagues to found the Interdisciplinary Plant Group (IPG).

The IPG is neither a dues-paying society nor a club with monthly meetings. Rather, it's a collection of colleagues who say, "We want to work together."

Operating on the principles of openness, communication and collaboration, the IPG has created a community of 57 researchers — including 19 members of the American Association for the Advancement of Science (AAAS) — across MU colleges, schools and departments. The IPG continues to transform campus culture, pulls in about $12 million in research funding a year and helps make Mizzou one of the 15 best plant and animal science institutions in the world, as ranked by Thomson Reuters.

Known for its work in plant genetics, plant hormone signaling, and insect and fungal resistance, the group is now bringing its cooperative model to bear on the vital issue of food security (consistent access to nutritious food) and joining as a lead partner in the International Food Security Alliance.

The alliance is a collaboration among a dozen universities across the globe to study the root systems of food crops, including ways to make them more drought tolerant. It is a pressing challenge for a planet that will require 70 percent more food to feed the 9 billion people walking the globe by 2050.

All About Atmosphere

Dale Blevins came to Mizzou in 1978 as an assistant professor of plant physiology soon after the IPG formed.

Like a root system in search of water, MU's plant professors at the time were forced to reach out to one another for the resources necessary to do their work. Budgets were tight and equipment hard to come by; sharing was a survival mechanism.

It forced graduate students in particular to spend time in many different labs, interacting with professors and learning things they otherwise wouldn't. They and their faculty mentors quickly saw this as valuable, Randall says.

And it wasn't just letting someone use a piece of equipment, Blevins says. It was taking time to train the person how to use it, troubleshooting any problems and truly collaborating on research.

That collaboration allowed Blevins to solve a nagging puzzle from his childhood on a Missouri farm during the droughts of the early 1950s. Blevins had wondered why orchard grass, which normally burned in the dryness and heat, stayed green when it grew among the alfalfa crops.

Here are some of the Interdisciplinary Plant Group's researchers who are collaborating on drought. Several are pursuing a large study on drought in corn roots in the lab and the field.

SCOTT PECK
associate professor of biochemistry: An expert in protein dynamics, Peck studies how drought affects protein synthesis, movement and behavior in corn.

PAULA MCSTEEN
associate professor of biological sciences: A plant growth hormone expert, McSteen studies how hormones impact lateral root development in drought-stricken corn.

DAVID BRAUN
associate professor of biological sciences and director of the Missouri Maize Center: Braun studies how, under drought, plants regulate the transport of sugars from leaves to roots, spurring growth and water uptake.

HENRY NGUYEN
Missouri Soybean Merchandising Council professor of plant sciences and director of the National Center for Soybean Biotechnology: A genomics expert, Nguyen studies the genetic basis for drought tolerance in soybeans.

ROBERT SHARP
professor of plant sciences and director of the IPG: An expert on the physiology of root growth, Sharp studies how drought affects root system development, primarily in corn.

FELIX FRITSCHI
assistant professor of plant sciences: Fritschi conducts field research on root growth, water use efficiency and nitrogen fixation in relation to drought.

SHERRY FLINT-GARCIA
USDA Research Geneticist and assistant professor of plant science: Geneticist Flint-Garcia crosses drought-tolerant traits into different corn varieties to see how they're expressed.

MELVIN OLIVER
research leader at USDA Agricultural Research Service: Oliver, a plant biologist, studies how dehydration affects the metabolic capabilities of plant cells.

Read how plant breeders put new research into next season's seeds. *mizzoumagazine.com/spring2013*

† Plant science professors **Robert Sharp,** left, and **Felix Fritschi** are pioneering a drought research technique that uses a "rain-out shelter." The giant glass structure on rails shields crops from rain, allowing the experimenters, rather than nature, to determine how much moisture the plants get and when.

With the help of water relations expert and IPG member Stephen Pallardy in the forestry department, Blevins proved that orchard grass intertwines its roots with the deep-rooted alfalfa, allowing water and other nutrients to transfer to the shallow-rooted plant.

It's a finding that could lead to planting strategies that increase the drought survival rates for shallow-rooted food crops. This new understanding required Pallardy's input, Blevins says.

"The thing with the plant people was: We liked one another," Blevins says of the early days. Friendship made the system work. "We'd just go wherever people had the equipment, back and forth, seamless."

Those friendships are still there. The group gets together for annual Christmas parties, not-quite-annual weekend retreats to Lake of the Ozarks, and, for the past three decades, an International Plant Biology Symposium that draws plant researchers from around the world every May.

"The best way I can describe it is that I think of myself first and foremost as a member of the IPG, then I think about what department I'm in," says Robert Sharp, current IPG director and professor of plant sciences.

Gathering Strength

That team atmosphere helps MU attract and retain world-class researchers such as Sharp, a root physiologist, and National Academy of Sciences member Jim Birchler, a corn geneticist.

Mel Oliver, research leader at the USDA Agricultural Research Service on campus and new AAAS member, says the IPG was "a huge factor" in his decision to come to Columbia in 2005. Oliver had already won several agricultural research awards for his work in desiccation — how some plants can be sucked completely dry and still survive — and was well along in his career when the USDA post at Mizzou opened up. He had passed on other job opportunities, but this one was different. "It took me less than a day to say, 'Yep, I'm going to apply.' "

David Braun and Paula McSteen, both associate professors of biology, also were lured by the IPG.

"We had multiple offers, and Missouri was the strongest in terms of the collaborative nature of the people and the science," Braun, PhD '97, says. "Here, people naturally see connections about how they pursue science. I never did anything with roots and drought before. But it's been a natural thing to work on here. My research has really blossomed."

Bringing together a team of people with different perspectives is a great way to do science quicker, Braun says.

But being a great place for collaboration and being known for it around the world are different things.

Like a flower attracting bees to disperse its pollen, the IPG's annual research symposium is most responsible for spreading the group's reputation globally.

Internal grant money in 1981 launched the first

RANDY MERTENS

three symposia. In 1984, a new permanent state program — Food for the 21st Century — provided annual funding for the symposium and gave crucial funding for faculty salaries, student fellowships, and travel and training grants.

"The idea of the symposium was to bring people into the university for a two- to three-day conference, expose them to us and us to them, and give opportunities for graduate students and postdoctoral fellows to network," Randall says.

This year's May 29–31 symposium will be the third in a series on root biology, with one topic being drought — an area with which Sharp is familiar.

No Drought of Ideas

For more than 30 years, Sharp has been studying corn roots and drought, which is the biggest limiting factor in crop production worldwide.

Columbia, being in the Missouri River basin, is an excellent testing ground for drought research because some part of the basin is in drought nine out of 10 years. "This is a frequent occurrence, not a rare occurrence," Sharp says. "It's also a worldwide occurrence."

Figuring out how root growth is regulated so as to increase root length (without sacrificing nutrient uptake at shallow soil levels) can make a big difference in dry climates, Sharp says. He cites Australian wheat crops, where an additional 4 inches of root growth can result in 10 to 20 percent greater yield.

There are "excellent prospects for improvement," Sharp says, "because we know so little" about roots. Being underground, roots are notoriously difficult to study compared to the rest of the plant.

Until recently, his work has been entirely in the lab under controlled conditions, seeing how roots respond to different levels of carefully calibrated soil moisture. But in the past couple of years, Sharp has teamed up with fellow IPG member Felix Fritschi, assistant professor in plant sciences, to take his theories to the field.

They are using a new "rain-out shelter," which looks like a big greenhouse on rails. Researchers can roll it over their test crop when it rains to preserve drought conditions. This gives them the ability to control how much water the plants get and when. But it still leaves the plants vulnerable to the vagaries of nature. Unlike in the lab, soil moisture is not uniform, and air and ground temperatures fluctuate. The plants are targets for fungus and insect pests. All these factors might influence how the roots behave.

"To me, it's exciting trying to figure out how things work in the real world," Fritschi says. "How do we feed the world? How do we translate the basic lab science into more corn or more soybeans? Ultimately, that needs to be done out in field conditions."

Oliver comes at the problem differently. Rather than try to figure out how drought-sensitive plants can be made more drought tolerant, Oliver studies plants that are already drought-tolerant and tries to determine what makes them that way.

For years he has done work on plants, including ferns and mosses, that can withstand desiccation, or total dehydration, and he is tracing their evolutionary family trees to home in on genes they share with their distant food crop cousins.

Oliver says early land plants used to tolerate total dehydratrion, but they faced a trade-off: Having dehydration-tolerant leaves also meant being slow-growing and small. That's a trade most plants long ago rejected. But they still carry genes for the trait — evidenced, Oliver says, by their seeds, which can survive for years while they wait for a little water to sprout.

Prompted by his IPG colleagues, Oliver has turned his attention to corn and other food crops to figure out how to revive those lost traits and increase drought tolerance without overly sacrificing growth.

"If it's the difference between crops surviving and not surviving in the developing world, that's a big deal," Oliver says.

The Next Century

Chancellor Brady J. Deaton, who leads the federal Board for International Food and Agricultural Development, calls water "the challenge of the next century." Learning how to grow 70 percent more food over the next 40 years on less land using less water will be the difference between a rising and falling standard of living for everyone.

"It's a vital issue," Deaton says. "It's an inherent part of what our university does."

And it's what motivates Fritschi and his colleagues. "That's why I'm doing this," he says. "That's why I'm working in the field. It's critical we have more drought-tolerant plants if we want to feed the world."

The clock is ticking.

"A physiologist can't solve it, a biochemist can't solve it, a geneticist can't solve it — it's going to take the whole bloody works," IPG founder Randall says. "Can we solve it in time? We better hope so."

Randall says a lack of funding the past 20 years for basic agricultural research will likely mean higher food prices.

"We need every weapon we can get. I think cooperative, interactive, cross-disciplinary research will help us get there faster. The IPG has proven that time and again." **M**

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