GROWING TIPS

2015 VOLUME 1

ANNUAL MAGAZINE OF THE
TRANSLATIONAL PLANT SCIENCES PROGRAM
AT VIRGINIA TECH

Virginia Tech
Invent the Future

WELCOME

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Rebranding to Translational Plant Science

It is my pleasure to introduce the first magazine under our program's new brand: the Virginia Tech Translational Plant Sciences (TPS) graduate program. We feel that this name is more representative of our group than our former name, Molecular Plant Sciences (MPS), because it better articulates the convergence of "molecular" and "applied" plant research here at Virginia Tech.

MPS developed at a time when plant researchers self-identified as either "applied" or "molecular" plant researchers. These identities stemmed from whether they used primarily physical/chemical experimental methods (hence "applied"), or molecular (rDNA) methods to investigate plant biology. Based upon a shared methodological proclivity, the latter group of faculty organized into what became the Molecular Plant Science Graduate program. Many of the rDNA technologies at that time were restricted to "model" plant species. Thus, the distinction between applied and molecular research was determined by both the limitations and opportunities of rDNA technology in only a few plant species.

The rebranding of the MPS to TPS is driven by innovations in both DNA sequencing and reverse genetic technologies that have developed in the past few years. Next Generation DNA sequencing is now cost effective for any plant genome (at least the transcriptomes). Similarly, advances in RNA interference, Viral Induced Gene Silencing, and genome editing TALON and CAS-CRISPR technologies are sufficiently efficient to allow their use in most any plant species. This liberation from the narrow confines of "model plant species" means that detailed investigations of molecular processes of any crop species (even wild noxious weeds) is now possible.

The technological barriers previously separating "molecular" from "applied" plant research are rapidly falling. This means that the objectives of basic and applied plant researchers are also rapidly converging. In short, the opportunities to convert fundamental molecular knowledge about a crop species into improved elite crop varieties is on the verge of becoming interwoven scientific endeavors. We aspire to become leaders in this convergence of molecular and applied research both in our research programs and student training.

The rebranding to translational research is a relatively new concept to plant biology researchers. However, for about a decade the National Institutes of Health have emphasized and incentivized collaborative research teams that can generate novel basic biological knowledge and then quickly translate this knowledge into novel therapies. This justification for basic research is recognized and rewarded by legislative bodies that fund public sponsored research. There is every reason to believe similar trajectories will emerge at agencies that fund plant science research.

ABOUT TPS

The Graduate Program in Translational Plant Sciences (TPS) at Virginia Tech allows students interested in pursuing a Ph.D. degree in this discipline to work in a wide variety of research areas ranging from plant genomics to disease resistance, metabolic engineering, bioproduction and bioprocessing, and forest biotechnology.

TPS degree candidates who enroll in the program participate in several rotations through laboratories of interest. The program of study includes selections from a range of course offerings, tailored to the background and interests of each student. At the end of the first or second semester of enrollment, a permanent advisor is selected in whose laboratory the dissertation research will be conducted.

The diversity in the TPS program is evident by looking at the federal agencies that fund them: National Science Foundation, United States Department of Agriculture, Department of Energy, and National Institute of Health. Moreover, many laboratories are also supported by various Virginia and US grower organizations and industry.

It will take a little while to build the TPS brand to the same degree of recognition as MPS. This year was spent with the necessary, and admittedly awkward, "MPS/TPS" co-designation. Fortunately, we had a surplus budget to enable a team of TPS faculty to update/create the TPS website with contemporary videos to build the TPS brand and presence on the internet. We owe them many thanks for their efforts.

As a founding member of MPS, it has been my pleasure to see its many successes over the years.
In this decade, I think that we will likely implement both genomic and gene editing technologies as a regular course of our research programs, and in doing so also find a sense of pride in describing our results as Translational Plant Science.

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DON'T PLANT INVASIVE SPECIES IN QUEST FOR GREENER PASTURES, RESEARCHERS SAY

Few agribusinesses or governments regulate the types of plants that farmers use in their pastures to feed their livestock, according to an international team of researchers that includes one plant scientist from Virginia Tech. The problem is most of these so-called pasture plants are invasive weeds.

In a Proceedings of the National Academy of Sciences study this month, the scientists recommended tighter regulations, including a fee for damage to surrounding areas, evaluation of weed risk to the environment, a list of prohibited species based on this risk, and closer monitoring and control of natural area damage.

The findings were also highlighted Nov. 12 in Nature.

The research team — led by scientists at the Australian National University — surveyed agribusinesses in eight countries on six different continents to see what species are planted in pastures, what traits are selected for, and what measures are taken to guard against invasion.

In response to human population boom and increased global food demand, some farmers resort to planting aggressive, fast-growing species in order to increase their herd size without breaking the bank. This extensive growth allows for greater cattle forage, but has a long global history of escaping the paddocks and invading natural areas, where they squelch out biodiversity, suck up available water resources, enhance fire cycles, disrupt the behavior patterns of pollinators, and alter nutrient and trophic levels.

In turn, about $34 billion per year is spent annually in the United States on invasive weed management, said Jacob Barney, an assistant professor of plant pathology, physiology, and weed science in the College of Agriculture and Life Sciences, Fralin Life Science Institute affiliate, and third author of the study.

"Meat consumption is increasing globally, which will increase animal production, and thus increase demand for forages improved for forage quality, productivity, and tolerance of poor growing conditions — all traits that may facilitate invasion into the natural ecosystem, making the invasion problem worse," said Barney, who is also a core faculty member in Virginia Tech's Interfaces of Global Change program.

"The weed problem faced by the USA and other countries is already enormous," said Don Driscoll, an associate professor at the Australian National University and lead author. "It makes sense to have new regulations that discourage agribusinesses from releasing more aggressive varieties of these existing weeds. A polluter-pays system applied across the livestock and feed industry would be an important disincentive that could help to solve this escalating weed problem."

A premiere Research Institute of Virginia Tech, the Fralin Life Science Institute enables and enhances collaborative efforts in research, education, and outreach within the Virginia Tech life science community through strategic investments that are often allied with colleges, departments, and other institutes.

- Originally published in VT News, Dec. 2, 2014

SCIENTISTS WEED OUT PESKY POISON IVY WITH DISCOVERY OF KILLER FUNGUS

Much to the chagrin of gardeners, hikers, and virtually anyone enjoying the outdoors, one of the hazards of summer is picking up an itchy poison ivy rash.

But researchers in the Virginia Tech College of Agriculture and Life Sciences have found an effective way to kill poison ivy using a naturally occurring fungus that grows on the fleshy tissue surrounding the plant's seed, potentially giving homeowners and forest managers the ability to rid landscapes of the pernicious pest. Their findings could make the maddening itch of the summer season a thing of the past for the untold millions who are allergic to the plant.

The study was published this week in the journal Plant Disease and is a first of its kind on a plant that affects millions but has had surprisingly little research done on it.

John Jelesko, an associate professor of plant pathology, physiology, and weed science, began studying the plant after experiencing a nasty poison ivy rash himself while doing some yard work. Much to his surprise, there was scant research focused on the plant itself. Most of the work was centered on urushiol, the rash-causing chemical found in the plant's oils. Urushiol is extremely potent. Only one nanogram is needed to cause a rash, and the oil can remain active on dead plants up to five years.

But rather than focusing on urushiol, Jelesko set about studying ways to kill the plant itself. He worked with Matt Kasson on the project, a senior research associate in the same department.

"This poison ivy research has the potential to affect the untold millions of people who are allergic to poison ivy," said Jelesko, a Fralin Life Science Institute faculty member. "We have the makings of a nonchemical way to control an invasive plant that can be used by homeowners and others who manage outdoor sites."

Their work is especially valuable in light of the fact that a 2006 study showed that as the planet warms, poison ivy is predicted to grow faster, bigger, and more allergenic, causing much more serious reactions that could send an increasing number of people to the doctor for prescription medications.

John Jelesko and Matt Kasson have discovered a natural fungus that kills poison ivy. Photo credit - Zeke Barlow

"When poison ivy can't be treated with over-the-counter treatments and requires an outpatient visit, then we are talking about a public health concern that is very real," said Kasson.

The research team discovered the killer fungus in their initial attempts to generate microbe-free poison ivy seedlings to use in their studies. Jelesko noticed that not only were some of the seeds failing to germinate, but on the seedlings that did germinate, there was a blight wiping out the young seedlings. Jelesko enlisted the help of Kasson to isolate what he suspected was a fungus causing disease in the plants. The team discovered that the fungus was growing on all the plants that died and the seeds that didn't germinate.

The fungus caused wilt and chlorophyll loss on the seedlings just by placing it at the junction of the main stem and root collar of the plant at three weeks post-inoculation. At seven weeks post-inoculation, all but one of the plants had died.

Though herbicides are available to kill poison ivy, Jelesko and Kasson said that if this fungus were developed into a commercial application, it would not only be more effective than its chemical counterparts, but also have the benefit of being completely natural.

"We have to keep in mind that the chemicals used to control poison ivy are general herbicides, meaning that they will affect and probably kill many other plant species, so their use in large areas is not always practical," said Thomas Mitchell, associate professor of fungal biology and molecular genetics at Ohio State University who is familiar with the research but not affiliated with it. "This work shows promise for an alternative approach to the use of chemicals and has great potential as a biological control alternative. This type of approach, using native pathogens to control noxious and invasive plants, is gaining more much deserved recognition."

Kasson, whose research is funded by the U.S. Department of Agriculture Forest Service, believes it would be relatively simple to develop a soil granular to spread on top of poison ivy-infested areas in yards and recreational areas such as campgrounds to naturally infect the plants and kill them.

After Kasson successfully isolated the fungus in pure culture from infected plants, a DNA analysis revealed that the fungus — Colletotrichum fioriniae — is also widely known as an insect pathogen that kills an invasive bug that infests and kills hemlock trees.

In all of the natural world, only humans are allergic to poison ivy and its itch-inducing oil, urushiol.

"Humans appear to be uniquely allergic to urushiol," said Jelesko. "Goats eat it, deer eat it, and birds eat the seeds, all to no ill effects."

Jelesko and Kasson have filed for a patent disclosure of their current findings, and say that this research just scratches the surface of possible avenues for the study of poison ivy.

Nationally ranked among the top research institutions of its kind, Virginia Tech's College of Agriculture and Life Sciences focuses on the science and business of living systems through learning, discovery, and engagement. The college's comprehensive curriculum gives more than 3,100 students in a dozen academic departments a balanced education that ranges from food and fiber production to economics to human health. Students learn from the world's leading agricultural scientists, who bring the latest science and technology into the classroom.

- Written by Amy Loeffler. Originally published in VT News, June 11, 2014.

WHERE ARE THEY NOW?

Gillaspy Lab:
Elitsa Ananieva, (Ph.D., 2009) Assistant Professor of Biochemistry/Nutrition, Des Moines University
Ryan Burnette, (Ph.D., 2004) Vice President of WCG Biosafety, a division of the WIRB-Copernicus Group, Inc.
Jenna Hess, (M.S., 2009) Director of Operations, Biosafety, WIRB-Copernicus Group
Aida Nourbakhsh, (Ph.D., 2012) Postdoctoral Associate, Virginia Commonwealth University School of Medicine

Jelesko Lab:
Sherry Hildreth, (Ph.D., 2009) Postdoctoral Associate, Virginia Tech.
Stacey Simon, (Ph.D., 2007) Program Manager, US Dept. Education
Jian Sun (Ph.D., 2008)(Co-advised with John McDowell), Scientist, Genescript, China
Alexandra Weisberg, (Ph.D. 2014) Postdoctoral Fellow, Oregon State Univ.

McDowell Lab:
Ryan Anderson, (Ph.D., 2011) Postdoctoral Associate, University of North Carolina
Devdutta Deb, (Ph.D., 2013) Postdoctoral Associate, Yale University
Troy Hoff, (Ph.D., 2008) D.O., Psychiatry, Richmond, VA
Toni Mohr, (M.S., 2004) Research Associate, University of California, Berkeley
Stacey Simon, (Ph.D.,2007) Science and Engineering Program Manager, US Department of Education

Tholl Lab:
Reza Sohrabi, (Ph.D., 2013) Postdoctoral Research Fellow, Molecular, Cellular, & Developmental Biology, University of Michigan
Martha Vaughan, (Ph.D., 2010) Research Molecular Biologist, Bacterial Foodborne Pathogens and Mycology Unit, USDA-ARS-NCAUR, Peoria, IL

Tokuhisa Lab:
Alice Mutiti Mtweeta, (Ph.D., 2009) Lecturer of Soil Microbiology and Biotechnology and Assistant Dean for Post Graduate Studies, School of Agricultural Sciences, University of Zambia, Lusaka, Zambia
William Herring Wadlington, (M.S.,

2011) Ph.D. candidate at the University of Illinois

Westwood Lab:
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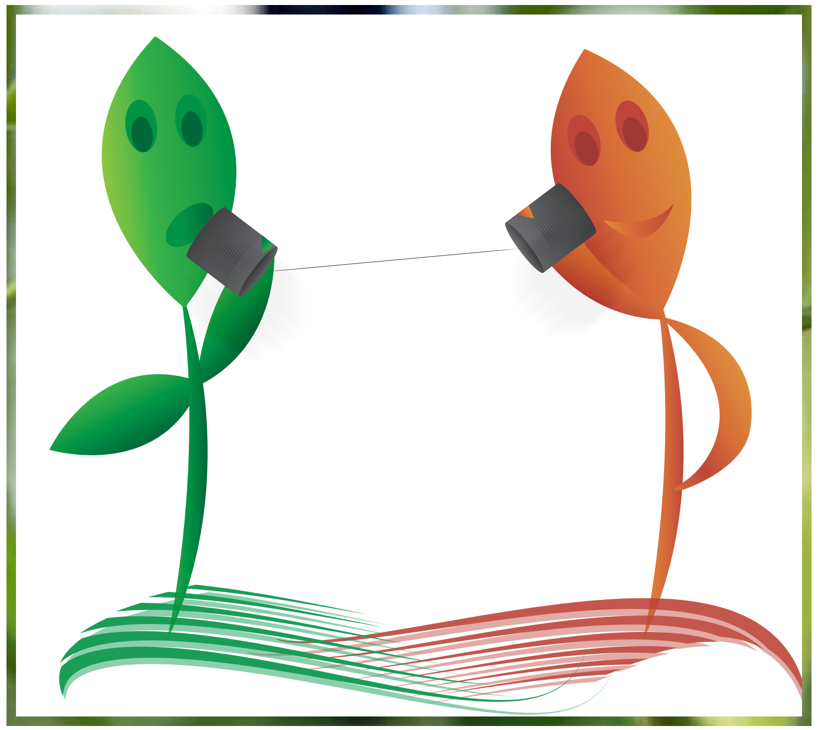
Gunjune Kim, (Ph.D., 2014) Postdoctoral Associate, Virginia Tech

Winkel Lab:
Kevin Crosby, (Ph.D., 2008) Postdoctoral Fellow, University of Colorado, Denver - Anschutz Medical Campus, Denver, CO.
Peter Bowerman, (Ph.D., 2010) Scientist, BASF, Durham, NC
Melissa Ramirez, (Ph.D., 2008) Teaching Assistant Professor, NC State, Raleigh, NC
Will Slade, (Ph.D., 2013) Postdoctoral Research Associate, University of North Carolina at Chapel Hill, Chapel Hill, NC

Veilleux lab:
Nan Lu (Ph. D.,2013) University of North Texas, Denton Texas
Sukhwinder Singh Aulakh (Ph. D., 2012), Donald Danforth Plant Science Center, St. Louis, Missouri
Norma Costanza Manrique (Ph.D., 2013), Michigan State University, East Lansing, Michigan
Sarah Hudson Holt (Ph. D., 2012), lab manager, Virginia Tech
Juan Jairo Ruiz-Rojas (Ph. D., 2010), Industrial Plant Geneticist, PepsiCo, Hawthorne, New York

Vinatzer Lab:
Rongman Cai, (Ph.D., 2012) Bioinformatics Scientist, National Institutes of Health Clinical Center, Bethesda, MD.
Christopher Clarke, (Ph.D. , 2012) USDA NIFA Postdoctoral Research Fellow, Dr. Jim Westwood's Lab, PPWS, Virginia Tech, Blacksburg, VA.
Shuangchun Yan, (Ph.D., 2010) Postdoctoral Research Fellow, Massachusetts General Hospital/ Harvard Medical School, Cambridge, MA.



Sandeep Rana, a doctoral student focusing on weed science, and Assistant Professor Mizuho Nita (right) at the Alson H. Smith Agricultural Research and Extension Center in Winchester, VA.

TRANSLATIONAL EDUCATION: GRADUATE STUDENTS LEARN BASIC TO APPLIED PLANT SCIENCE

According to the U.S. Census Bureau, the world's population is over 7 billion and counting. And, according to Nobel Laureate Norman Borlaug, it took almost 10,000 years for food production to reach the current level of 5 billion tons per year, and in only another 25-30 years, we will have to nearly double this amount in order to meet the global food demand.

What this means is that as more and more people roam the earth, farmers are having a progressively harder time keeping up with the food demand.

In response, farmers tend to plant the same strains of high-yield crops, but when massive amounts of the same plant grow prolifically, the plants lose their ability to develop gene resistance against pathogens.

John McDowell, a professor of plant pathology, physiology, and weed science in the College of Agriculture and Life Sciences, is determined to provide farmers with the right knowledge to grow crops effectively.

In an effort to do so, McDowell studies the interplay between plant pathogens and their host's ability to protect against them. These pathogens have the ability to wear down the plant's immune system using pathogen "effector" proteins, which can manipulate certain regulatory proteins in order to make the host plant more susceptible to infection. In turn, plants have evolved to produce "surveillance" proteins, which can trigger strong immune responses, including cell suicide at the site of the invading pathogen.

Broadly speaking, McDowell studies how plant pathogens manipulate host plants including how certain pathogens cause disease, how pathogens extract nutrients from their host with implications for developing new strategies of resistance, and how research on plant-pathogen interactions can be translated into new strategies for disease control.

Most of McDowell's work focuses on the specific plant model Arabidopsis and its natural pathogen H. arabidopsidis, or downy mildew disease. These pathogens are related to those in a similar disease, the late blight of potato, which is the main case study in McDowell's translational plant science graduate course, GRAD 5134—Translational Plant Science.

One of the main reasons for this case study is that plant-pathogen diseases like late blight are a continuing threat to global food security, causing hundreds of billions of dollars in damage every year. In fact, a 2013 Nature article suggests that a possible past catastrophe that may strike again is death by fungus: the potato blight fungus, that is.

According to the article, Phytophthora, the causal agent of late blight, is responsible for almost $7 billion per year in damage. It attacks the roots and stems, and its most common hosts are the tomato and potato.

This pathogen was the cause of the Irish potato famine in the 1840s, which is a historical event that offers perspective now, which is why McDowell uses it as a case study in his course.

As part of the study, McDowell not only teaches the history of blight, including its causes and effects, but he urges students to understand the pathogen in a cross-disciplinary, multi-perspective approach. That is, he teaches students the translational side of plant science: how to use basic scientific knowledge of the pathogen, like that it sends out proteins that attack certain characteristics of the host, in order to aid farmers in their efforts to produce more sustainable agriculture.

Graduate students in translational plant sciences are learning exactly this, which is how to apply basic science knowledge, such as the biochemical makeup of these plant-pathogen interactions, to agricultural and economical needs, which include farmer education.

In addition, late blight poses a potential threat, as Nature reminds us, as it could find its way into a high-crop area with low resistance. The pathogen originally came over through produce on its way by boat, and since the pathogen is prolific in agricultural areas of Europe and North Africa, it could progress into a problem.

"The pathogen always wins," McDowell told his students during class. "It just depends on how long it takes to win. That's where we come in, the translational plant scientists. It's our goal to stop it or at least slow it down."
For McDowell, translational plant science works like Virginia Tech's motto: Ut Prosim, That I May Serve. The educational goal is to apply scientific knowledge for the development of better agricultural practices and sustainability, while also training professionals for successful communication with the public, and farmers, on effective agricultural management and production practices.

Effective practice includes helping farmers streamline their production to feed the growing global population by having as high a crop yield as possible. Factors fighting against farmers include farmer education, lack of soil rotation, global change in the form of climate change, pollution, invasive species, habitat loss and disease, seed quality, and pesticide use.
So, how exactly will we keep up with food demand? Let's start by asking these students.

(I hope to add more commentary from McDowell, as well as from one or two of this students. --CH)

The Agricultural Research and Extension Centers (AREC) Tour

An additional example of this translational educational experience this what's commonly known as the AREC Tour. The Agricultural Research and Extensions Centers are affiliated with Virginia Tech and the College of Agriculture of Life Sciences. Graduate students in plant pathology, physiology, and weed science are required to go on the tour once during their graduate training.

During the tour, graduate students visit the various locations across the state of Virginia. The goal is for them to see how research is conducted in the field, as well as how it serves to educate and inform the agricultural industry.

-Written by Cassandra Hockman, March 2015

In GRAD 5134, Professor John McDowell responds to translational science-based grant proposals by the course's graduate students.

Graduate students Xuewen Feng (left), Charlotte Oliver, Anna Benton, and Kasia Dinkeloo at the Alson H. Smith Agricultural Research and Extension Center in Winchester, VA, which serves the state's commercial fruit and food industries through research, education, and outreach.

STUDENT SPOTLIGHT

LAB SPOTLIGHT: NINA WILSON AND NIKI MCMASTER STUDY TOXINS THAT THREATEN FOOD SAFETY

Last October, Nina Wilson and Niki McMaster went to Bari, Italy to learn more about food safety standards for mycotoxins – fungal chemicals that are harmful to domestic animals and humans – across the globe. Improved methods to track these mycotoxins in food and feed will enable scientists like Wilson and McMaster to provide agricultural industries with more effective food safety regulations.

Wilson is a Ph.D. student and McMaster is a research associate in the Schmale Lab in the department of plant pathology, physiology, and weed science. In Bari, the duo attended a workshop on mycotoxin detection techniques, hosted by the Institute of Sciences of Food Production of the National Research Council of Italy and the International Society for Mycotoxicology.

The trip was supported by the U.S. Wheat and Barley Scab Initiative (USWBSI), which is a research organization that works to improve food safety and supply by attempting to reduce the impact of Fusarium Head Blight – also known as scab – on wheat and barley. Scab is a disease caused mainly by the fungus Fusarium graminearum, which often results in grain being contaminated with mycotoxins such as deoxynivalenol – also known as DON, or vomitoxin for what it does to the gastrointestinal tract of some domestic animals.

McMaster manages mycotoxin testing services in the Schmale Lab. There are four DON testing labs in the U.S. supported by USWBSI – Schmale's lab is one of them.

"There are FDA limits on how much mycotoxin can be in our grain," said McMaster, "so we provide testing services for USWBSI stakeholders that will help develop new varieties of wheat and barley with resistance to mycotoxins. Resulting technology and mitigation techniques for mycotoxins such as DON will ensure a safe supply of food and feed."

During the workshop, McMaster and Wilson met scientists from all over the world, while receiving extensive hands-on training using cutting-edge technologies.

"I had a really great time and learned so much," said Wilson. "I am so glad that I learned new detection techniques that I could bring back to the lab as a graduate student and as a working professional. My work involves testing for DON detoxifying agents such as bacteria or fungi, and this workshop helped me understand what tools, resources, and protocols are available for testing my work."

-Written by Cassandra Hockman, March 2015

Doctoral student Nina Wilson and lab associate Niki McMaster attended a workshop on mycotoxin detection techniques last fall in Bari, Italy. The workshop was hosted by the Institute of Sciences of Food Production of the National Research Council of Italy and the International Society for Mycotoxicology in Bari, Italy.

MAKING PLANTS MORE NITROGEN EFFICIENT MAY PAY DIVIDENDS FOR DEVELOPPING COUNTRIES, FERTILIZERS

Sakiko Okumoto, an assistant professor of plant pathology, physiology, and weed science in the College of Agriculture and Life Sciences, investigates how plants may become more nitrogen efficient by studying the relationship between seedlings, mother plants, and the surrounding soil.

Her work has important agricultural implications for developing countries that heavily rely on nitrogen-based fertilizers, which become costly when oil prices rise.

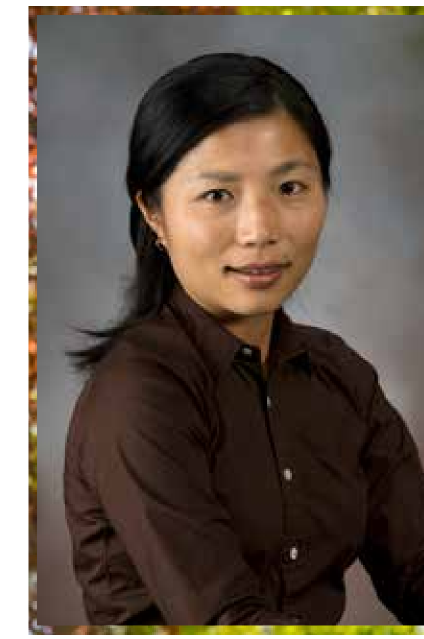
The overall goal of her research is to understand how nitrogen, which is quantitatively the most important nutrient in crops, is managed in plants. In particular, her research aims to understand how amino acids — one of the main forms of organic nitrogen in plant bodies — is sensed and transported.

In an effort to understand how plants may use nitrogen more efficiently, in her lab Okumoto has developed protein-based, fluorescent sensors that allows her to track amino acids in living cells. These sensors also help Okumoto and her lab to discover new molecular mechanisms within the plant that are involved in the regulation of amino acids.

Part of this amino acid regulation relates to the chemical makeup of the surrounding soil. The surrounding soil provides plants with nitrogen, but when the soil is devoid of a sufficient amount of nitrogen, the plants suffer.

The problem is that there is a lot of farming that takes place in arid lands lacking nitrogen, as in parts of Central and South America. It's common in dry agricultural areas to use nitrogen-based fertilizers for plants to receive sufficient nutrition. But the use of such fertilizers is not sustainable because these can be very expensive, particularly as prices rise on other products.

To bring these ideas together, Okumoto is also interested in discovering the molecular nature of amino acid sensors and their mode of action in plants. From here, she is currently trying to introduce a novel nitrogen storage molecule into land plants, which will ultimately help her achieve her goal of improving nitrogen usage efficiency and will pave the way for more sustainable agricultural practices.



Sakiko Okumota, an assistant professor of plant pathology, physiology, and weed science.

During the workshop Niki McMaster (left) and Nina Wilson (right) worked with cutting-edge technology in a hands-on lab environment, with assistant Stefania Valenzano of the Institute of Sciences of Food Production in Bari, Italy.

TALKING PLANTS:DAVID HAAK

What is the focus of your current research?

We are interested in the way plants respond to stress. Plants face an enormous array of consumers from diseases and insects to vertebrate herbivores. In addition, plants grow in a wide range of environments from very dry (the Atcama desert) to very wet (tropical rainforests). This means that plants must integrate their response to both biotic and abiotic stresses. This integration is orchestrated by the plants genome.

My lab studies the genomic level processes (e.g., transcription regulation, generation of alternative gene forms, interaction of genomic regions) that modulate plant responses to stress. To facilitate this we explore natural variation in plant stress responses among wild crop relatives. Currently, we are investigating responses in wild chili peppers and wild tomatoes. These two systems are important agronomically and are also tractable models for our genetic approach. Our ultimate goal is to understand how these pathways interact and identify ways in which they can be modified to improve sustainable agricultural production.

For decades plant breeders have relied on wild germplasm as a source of novel agronomic traits, but identifying the genetic basis for these traits is not trivial. The advent of high-throughput sequencing has revolutionized the field increasing the amount of data by orders of magnitude and therein reducing the time and effort needed to map novel genes. By combining traditional approaches with modern genomic tools we hope that our work in tomato and pepper can serve as a model for other crops, ultimately providing a resource for global food security, sustainable agriculture and, by focusing on wild crop relatives, conservation of important biodiversity.

How did you become interested in your line of research?

Like most biologists I spent my childhood turning over rocks in streams, fields, and woods to see what was there. This habit turned into insect collecting and a friendship with my grandparents' neighbor, who was an extension entomologist and agroecologist at Auburn University. It was Dr. Rodriguez who opened my eyes to the intricate interactions between plants and insects and the arms race between the plants and would be consumers.

This interest was broadened during my undergraduate days where I was fortunate enough to work in a research lab focused on drought physiology in soybeans. It was here that I found my passion for biochemistry and physiology and the ways in which these pathways are manipulated to facilitate plant responses to environmental conditions. Through this lens I was able to see that there are not just connections among organisms but, within organisms as well and that these connections have been shaped by evolution.

During my graduate work I realized that the only way to begin to understand these intricate relationships was to understand the genetic basis for these traits. Knowing the genes involved allows us to isolate their effects in common backgrounds and then pinpoint the ecologcial role for each trait. An admittedly reductionist approach, once we have the pieces we can begin to reassemble the integrated form and investigate how each piece fits. Of course this may all be biased by my need to see the world through rose colored polycyclic ringed glasses (sorry, a bit of geek humor).

What are some examples of plant stressors?

Some physiologists are apt to say that plants are always living under stress, even in a nice tidy growth chamber there may be low light stress. We are interested in the big stressors which lead to crop loss, things like drought, insect pests, and disease. These stressors tend to have large effects on plant growth and reproduction through a dramatic genomic reprogramming (turning off or on hundreds of genes).

Evolutionarily, plants have adapted to these stressors by co-opting existing signaling pathways to respond to particular stressors. Because they come from a common core set of pathways they share regulatory targets. This means that when one pathway is activated additional response pathways may also be affected. In some cases this is beneficial and in others it is inhibitory. For instance, under drought stress most agronomic plants have an increased susceptibility to pathogens.

Q&A

This is particularly important for crop plants for two related reasons. First, under current climate change scenarios both drought frequency and pest pressure are predicted to increase. Second, is that most crop species have a limited amount genetic diversity for breeders to work with. One place we can turn for solutions is natural variation among wild crop relatives. Here ecological and evolutionary processes have already done the hard work of uncoupling these traits interrelated traits.

In what ways is your work 'translational'?

Globally, we are facing several major challenges in the coming decades. Two important challenges are food security in a changing climate and the erosion of biodiversity. We are predicted to reach nine billion people in the next fifty years and to feed this growing population we will need to effectively double the yield of our major crops. This increase in yield will be limited by available land area. Already, we have converted large portions of our tropical rainforests to agricultural production. These productive ecosystems not only harbor over 60% of biological diversity (including most of the wild relatives for our major crops) they also serve as drivers of global biogeochemical cycles. This means that we must focus on improving the efficiency of food, feed, and fiber production on existing land resources.

My lab is investigating natural variation among wild tomatoes and wild chili peppers with an aim to identify novel resistance alleles for various stressors, including drought, diseases, and pests. To meet this challenge we employ genomic and quantitative genetic tools in an ecological framework. Some of these approaches include, comparative and population genomics, experimental transcriptomics, and landscape genomics. Our ultimate goal is to develop genomic tools and resources for the community. In this effort, we are dedicated to adapting crop plants to current and anticipated climate pressures and simultaneousluy cataloging and conserving natural genetic resources.

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ABOUT DAVID HAAK

Hometown:

Asheboro, NC

Educational Background:

BS in Biology, North Carolina State University
MS in Crop Science (Biochemistry and Plant Physiology), North Carolina State University
PhD in Biology (Evolutionary and Ecological Genetics), University of Washington

Hobbies:

2 Kids, Fishing, Hiking

Favorite thing to do around Blacksburg:

We are the outdoorsy types so if we are not at VirginiaTechniques Gymnastics center, or on the soccer field, you'll likely find us on a trail somewhere.

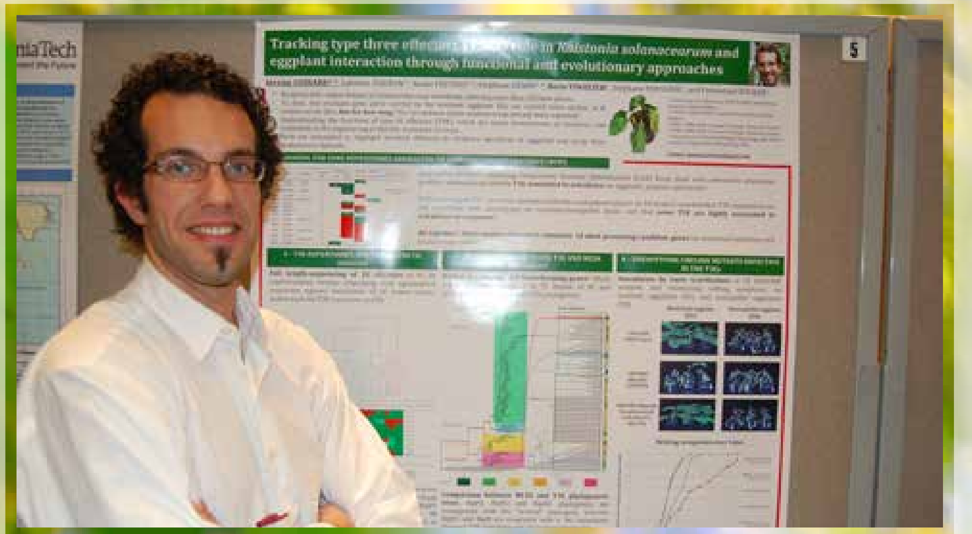
A favorite book or two:

A Sand County Almanac—Aldo Leopold
On the origin of species—Charles Darwin

A favorite quote:

When we try to pick out anything by itself, we find it hitched to everything else in the Universe.
- My First Summer in the Sierra , 1911, page 110. John Muir

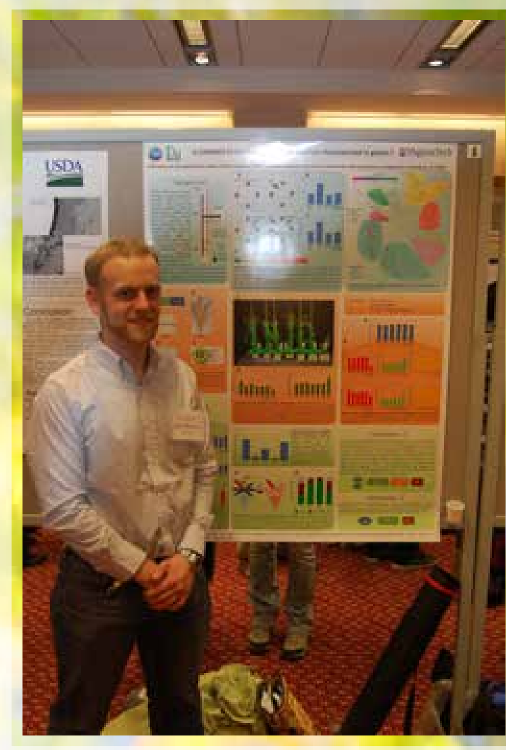
AROUND TPS

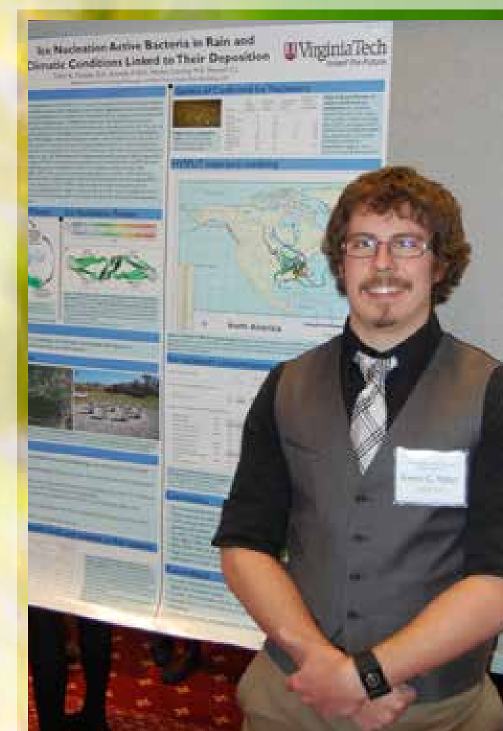


Jeremy Guinard, a visiting graduate student from France (PPWS, Vinatzer lab), presents a poster at the TPS Mini-symposium on his research on plant pathogenic bacteria.

Undergraduate student Shelton Boyd (PPWS, Pilot lab) won the poster competition at the TPS Mini-symposium.

Graduate student Julien Besnard (PPWS, Okumoto lab) presents a poster at the TPS Mini-symposium on amino acid transporters in plants.





Graduate student Kevin Failor (PPWS, Vinatzer lab) presents a poster at the TPS Mini-symposium on bacteria that may contribute tho the formation of rain and snow in clouds.

Graduate student Julien Besnard (PPWS, Okumoto lab) won the graduate student oral paper competition at the TPS Mini-symposium.

From left to right, the members of the Schmale lab: Niki MicMaster, Regina Hanlon, Nina Wilson, Hope Gruszewski, and David Schmale. Together, they work to mitigate toxins in ethanol co-products that are an important source of feed for domestic animals. The photograph was taken at the Vireol ethanol plant in Hopewell, VA.

FOR MORE INFORMATION

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