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Research News

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Plants with dormant seeds give rise to more species
Source: National Evolutionary Synthesis Center (NESCent). April 18, 2014

Seeds that sprout as soon as they're planted may be good news for a garden. But in the wild, a plant whose seeds sprouted at the first warm spell or rainy day would risk disaster. More than just an insurance policy against late frosts or unexpected dry spells, it turns out that seed dormancy has long-term advantages too: plants whose seeds put off sprouting until conditions are more certain give rise to more species.
When they first emerge from the soil, plant seedlings are very vulnerable, said co-author Rafael Rubio de Casas of the Universidad of Granada in Spain. "They're like babies. They don't have protective thorns or woody tissue any of the other defenses that are more typical of adult plants yet."

The tiny embryos of many plants can lie huddled inside their seed coats in a state of suspended animation for years before finally springing to life. The oldest known was a date palm that sprouted from a 2000-year-old seed recovered from the ruins of a fortress in Israel.

Taking advantage of data compiled over more than forty years by University of Kentucky seed scientists Jerry and Carol Baskin, who were also co-authors on the study, researchers analyzed seed dormancy data for more than 14,000 species of trees, shrubs, vines and herbs from across the globe.

When the researchers mapped the data onto the seed plant family tree, they found that plants with the ability to regulate the timing of germination in response to environmental cues were more likely to spin off new species.

"Having the capacity to fine-tune their development to the environment seems to be crucial for diversification," de Casas said.

Seed dormancy may help plants colonize new environments by preventing new arrivals from sprouting under conditions or at times of year when the probability of seedling survival is low.

The strategy is as ancient as seeds themselves. "Our results suggest that even the earliest seeds had this ability," de Casas said.

Plants whose seeds have since lost the ability may be more prone to extinction under future climate change, especially if the timing of sprouting is no longer in tune with their environment, he added.

Journal Reference: Charles G. Willis, Carol C. Baskin, Jerry M. Baskin, Josh R. Auld, D. Lawrence Venable, Jeannine Cavender-Bares, Kathleen Donohue, Rafael Rubio de Casas. The evolution of seed dormancy: environmental cues, evolutionary hubs, and diversification of the seed plants. New Phytologist, 2014; DOI: 10.1111/nph.12782

How a plant beckons bacteria that will do it harm

Source: Pacific Northwest National Laboratory. April 24, 2014

A common plant puts out a welcome mat to bacteria seeking to invade, and scientists have discovered the mat's molecular mix. The team showed that the humble and oft-studied plant Arabidopsis puts out a molecular signal that invites an attack from a pathogen. The study reveals new targets during the battle between microbe and host.

The study published this week in the Proceedings of the National Academy of Sciences reveals new targets during the battle between microbe and host that researchers can exploit to protect plants.

The team showed that the humble and oft-studied plant Arabidopsis puts out a molecular signal that invites an attack from a pathogen. It's as if a hostile army were unknowingly passing by a castle, and the sentry stood up and yelled, "Over here!" -- focusing the attackers on a target they would have otherwise simply passed by.

"This signaling system triggers a structure in bacteria that actually looks a lot like a syringe, which is used to inject virulence proteins into its target. It's exciting to learn that metabolites excreted by the host can play a role in triggering this system in bacteria," said Thomas Metz, an author of the paper and a chemist at the Department of Energy's Pacific Northwest National Laboratory.

The findings come from a collaboration of scientists led by Scott Peck of the University of Missouri that includes researchers from Missouri, the Biological Sciences Division at PNNL, and EMSL, DOE's Environmental Molecular Sciences Laboratory.

The research examines a key moment in the relationship between microbe and host, when a microbe recognizes a host as a potential target and employs its molecular machinery to pierce it, injecting its contents into the plant's cells -- a crucial step in infecting an organism.

The work focused on bacteria known as *Pseudomonas syringae* pv. tomato DC3000, which can ruin tomatoes as well as Arabidopsis. The bacteria employ a molecular system known as the Type 3 Secretion System, or T3SS, to infect plants. In tomatoes, the infection leads to unsightly brown spots.

Peck's team at the University of Missouri had discovered a mutant type of the plant, known as Arabidopsis mkp1, which is resistant to infection by Pseudomonas syringae. The Missouri and PNNL groups compared levels of metabolites in Arabidopsis to those in the mutant mkp1 form of the plant. Peck's group used those findings as a guide to find the compounds that had the biggest effect -- a combination that invites infection.

The researchers discovered a group of five acids that collectively had the biggest effect on turning on the bacteria's T3SS: pyroglutamic, citric, shikimic, 4-hydroxybenzoic, and aspartic acids.

They found that the mutant has a much lower level of these cellular products on the surface of the plant than found in normal plants. Since the resistant plants don't have high levels of these acids, it stops the bacteria from unfurling the "syringe" in the presence of the plant. But when the combination of acids is introduced onto mkp1, it quickly becomes a target for infection.

"We know that microbes can disguise themselves by altering the proteins or molecules that the plant uses to recognize the bacteria, as a strategy for evading detection," said Peck, associate professor of biochemistry at the University of Missouri and lead author of the PNAS paper. "Our results now show that the plant can also disguise itself from pathogen recognition by removing the signals needed by the pathogen to become fully virulent."

While Peck's study focused on bacteria known mostly for damaging tomatoes, the findings also could have implications for people. The same molecular machinery employed by *Pseudomonas syringae* is also used by a host of microbes to cause diseases that afflict people, including salmonella, the plague, respiratory disease, and chlamydia.

On the energy front, the findings will help scientists grow plants that can serve as an energy source and are more resistant to infection. Also, a better understanding of the signals that microbes use helps scientists who rely on such organisms for converting materials like switchgrass and wood chips into useable fuel.

The work opens the door to new ways to rendering harmful bacteria harmless, by modifying plants so they don't become invasive.

"There isn't a single solution for disease resistance in the field, which is part of the reason these findings are important," said Peck. "The concept of another layer of interaction between host and microbe provides an additional conceptual strategy for how resistance might be manipulated. Rather than trying to kill the bacteria, eliminating the recognition signals in the plant makes the bacteria fairly innocuous, giving the natural immune system more time to defend itself."

Journal Reference: J. C. Anderson, Y. Wan, Y.-M. Kim, L. Pasa-Tolic, T. O. Metz, S. C. Peck. Decreased abundance of type III secretion system-inducing signals in Arabidopsis mkp1 enhances resistance against *Pseudomonas syringae*. Proceedings of the National Academy of Sciences, 2014; DOI: 10.1073/pnas.1403248111

GM crops given green light by government

By Sarah Knapton, The Telegraph. 27 April 2014

Genetically modified crops grown to contain health boosting omega-3 fish oil have been given the green light by Defra in British trials which could see nutritionally enhanced food coming to British tables.

Genetically-modified food which boosts health could be on British dining tables by the end of the decade after the Government gave the green light for the first field trial of nutrient enriched crops.

The Department for Environment, Food and Rural Affairs today granted permission for Rothamsted Research to grow plants enhanced with the same omega-3 fatty acids found in fish oil, in a decision branded a 'milestone' by scientists.

The first seeds will be sown within weeks in secure fields in Hertfordshire and will be harvested in August.

The GM crop, where the plant's DNA has been combined with genes that produce fish oil, is among the first of a new generation of so-called ‘nutraceuticals’ –

plants whose genetic structure has been altered to boost dietary supplements.
If successful the plant oil will be fed to fish, such as farmed salmon, to boost their uptake, but it could eventually be used in oils and spreads such as margarine.
Professor Johnathan Napier, lead scientist of this project at Rothamsted Research, said: "Omega-3 doesn't occur in any other plant species but there is a real pressing need for it for health reasons.
"The way that fish currently acquire their omega-3, from algae, is not sustainable. So we are trying to find another source.
"Being able to carry out the field trial with our GM plants, means that we have reached a significant milestone in the delivery of our research programme.
"And just because we are talking about fish doesn't mean there couldn't be lots of other applications. This is something that could reduce our dependency on fish or supplements in the long term."
Omega-3 fatty acids have been widely linked to health benefits, such as lowering the risk of heart disease, cancers and neuro-degenerative diseases.
Although omega-3 is often described as fish oil, it is in fact made by microscopic marine algae that are eaten or absorbed by fish.
Farmed fish grown in cages are unable to absorb sufficient omega-3 in their diets so they have to be fed on smaller fish which critics claim is unsustainable.
The Rothamsted Research scientists have copied and synthesised the genes from the algae and then spliced them into a plant called 'Camelina sativa', known as "false flax", which is widely grown for its seed oil.
Although the main aim of the research is to produce GM crops that could be made into food for farmed fish, the seeds could eventually be used in other foods, such as margarine.
It is the first crop to be given permission since a wide-ranging report, commissioned by the government, gave the green light to GM in March.
Sir Mark Walport, the government's Chief Scientific Advisor recommended that Britain should begin production after finding GM crops were not only safe, but more nutritious than current crops.
GM crops are already widely used in the US, Canada, Brazil, Argentina and India. Around 85 per cent of all corn crops in the US are now GM.
Sir Mark has warned that Britain risks falling behind if it does not begin GM production soon.
Professor Cathie Martin, the John Innes Centre, which has been producing enhanced tomatoes in green houses said: "Modern diets contain low levels of omega-3 polyunsaturated fatty acids
"Diets with high omega-3 are strongly associated with health and protection from a range of chronic diseases including cardiovascular diseases,
"Cultivation of crops that produce oils high in omega 3 offers a sustainable supply of these health beneficial products for the first time."
Prof Jackie Hunter, Chief Executive of the Biotechnology and Biological Sciences research Council, which is helping fund the research said: "This research is seeking to provide an alternative source of omega-3 oil for the aquaculture industry that is seeking new ways to maintain and increase its sustainability.
"After many years of laboratory research this project has reached the point where only a field trial will show scientists if this could work in real world conditions."
However anti GM critics claim that omega-3 fish oils have been implicated in raising the risk of prostate cancer, and it is not clear whether GM-derived fish oils will be safe for human or animal consumption.

Putting Up Resistance
By Kerry Grens. The Scientist. June 1, 2014.

Will the public swallow science's best solution to one of the most dangerous wheat pathogens on the planet?
Beneath a steely and frigid Minnesota sky, the warm orange glow of a greenhouse beckons me to enter. But getting inside requires special security clearance and the donning of a white Tyvek gown, and visitors must shower upon leaving. Scrambling up a snowdrift outside the glass building affords me a less encumbered peek at what's inside: row upon row of wheat plants, riddled with a

fungal pathogen that has destroyed countless hectares of the crop in Africa and, more recently, the Middle East.

"There it is, Ug99," says Brian Steffenson, a plant pathologist at the University of Minnesota, as he taps the glass to point out the dark-red fungus flecking the leaves of the young plants. As they grow, their stems will form large pustules of the fungus that will go on to shed pathogenic spores. Ug99 is a strain of wheat stem rust that was first identified in Uganda in 1998 (and named in 1999). By 2001, Ug99 began appearing in fields in Kenya; in Ethiopia by 2003; Sudan and Yemen by 2006; and Iran a year later. It now plagues wheat plants in nine African and Middle Eastern countries. Should the pathogen establish a global presence, 90 percent of wheat varieties could succumb, with whole crops flopping over and rotting within weeks or months of infection. The annual global harvest of some 700 million tons of wheat would be decimated.

"Wheat is a very important cereal," says Ravi Singh, head of Irrigated Bread Wheat Improvement and Rust Research at the International Maize and Wheat Improvement Center (CIMMYT) in Mexico. "Twenty percent of [humans'] calories and about the same [percent of] protein are coming from wheat."

In late February, at the US Department of Agriculture's Cereal Disease Laboratory (CDL) in St. Paul, Minnesota, scientists are wrapping up their busy winter season, hosing down a greenhouse and finishing up their analyses of rust samples sent from other parts of the world. The CDL is one of only two places in the world sanctioned to work with Ug99, and only for a few months during the cold season. Should the fungus escape the confines of the biosafety greenhouse, it would be met with the inhospitable environs of a St. Paul winter, leaving no chance of getting a foothold in North America.

Some wheat varieties are resistant to Ug99, but they represent just 10 percent of the varieties grown around the world. And even these plants are not necessarily immune to infection. Ug99 continues to mutate and spread, and new virulent races, or biotypes, of the fungus that are able to skirt plant resistance strategies could emerge at any time. Just last year, for example, outbreaks of a novel stem rust race in Ethiopia and Germany infected Ug99-resistant wheat plants. In the oft-repeated words of the late wheat-breeding pioneer Norman Borlaug of the Rockefeller Foundation and CIMMYT, "Rust never sleeps."

Most wheat researchers and breeders agree that to protect plants from Ug99, they must develop wheat varieties with several rust-resistance genes, so that if the fungus mutates to outwit one defense, there are others there to take on the pathogen. The problem is that it can take years to achieve this goal using traditional breeding methods. In the meantime, favorable winds could spread Ug99 even farther, and the fungus continues to evolve resistance to wheat crops' natural defenses.

One way to hasten the development of a long-lasting stem rust–resistant wheat variety is to engineer plants' DNA to carry resistance genes, creating what are known as genetically modified (GM) crops. But at many of the facilities that develop wheat varieties—primarily led by academic breeding groups, in contrast to the commercial domination of corn and soybean development—such transgenic approaches are taboo, as public opposition, regulatory expenses, and genetic complexity have kept wheat transgenics off the market. "We could do millions of things [with transgenics]," says Jorge Dubcovsky, a wheat geneticist and breeder at the University of California, Davis, "but we have our hands tied."

Still, a few groups are forging ahead. Dubcovsky and other researchers have begun to clone rust-resistance genes from wheat and other taxa and identify their functions. Others are using those discoveries as springboards to compile the genes into constructs that could be employed to develop a plant with multiple forms of resistance. It's early days yet, says Brande Wulff at the Sainsbury Laboratory in Norwich, U.K., and downstream consumer resistance to the technology doesn't discourage him. It could take five to ten years before researchers will have something ready for breeders to try anyway, he says. "By then the public perception could have changed a lot."

Traditionally, breeders have introduced resistance traits into crops by crossing commercial plants with other wheat varieties or related taxa that are able to fend off a pathogen. Using this method, Borlaug successfully bred stem rust–resistant plants that thwarted other races of the once-devastating pathogen for four decades. (See "Wheat Whisperer, circa 1953.") Then, in 1998, scientists detected Ug99, a race of stem rust that had finally found a way around the crop's main rust defenses.

"The problem was [that rust resistance] lasted 40 years," says Les Szabo, a geneticist at the CDL. As a result, governments became complacent in their efforts to breed wheat varieties with different resistance genes and to track how rust races were evolving. Stem rust became "a forgotten corner of plant pathology," agrees Matt Rouse of the CDL. So when the pathogen reared its head again the late '90s, it took the wheat research community by surprise.

CIMMYT's Singh was one of the first to become aware of Ug99 when it emerged in Uganda, and right from the beginning, he says, it raised big concerns. What was especially alarming to him at the time was that many rust-resistant CIMMYT varieties, developed with the traits Borlaug introduced, were vulnerable to the new race. "Even from 1998, it was clear we would have trouble sooner or later," he says.

Initially, many African farmers turned to wheat that included the resistance gene Sr24 to protect their crops from infection, but by 2006, Yue Jin of the CDL and his colleagues identified a new variety of Ug99 in Kenya that could sidestep the defense.1 Then, in 2007, Jin and his colleagues found that yet another valuable resistance gene, Sr36, had also succumbed to the rapidly evolving fungus.2

While disheartening, such adaptations are not entirely surprising. Thanks to their large, dynamic genomes, rust species are extremely adept at overcoming host resistance to infection. And barberry—a ubiquitous shrub that serves as an alternative host to stem rust and often grows in close proximity to African wheat fields—might serve as a nursery for rust genetic diversity by offering a site where the fungus can reproduce sexually. Stem rust is so difficult to control, Singh has found that, on average, a single major rust-resistance gene becomes impotent just three to four years after it is introduced in the field. "Very rapidly, the genes we deploy [to protect plants against infection] are destroyed by rust," says Dubcovsky.

A more durable way to protect wheat against Ug99 would be to insert multiple rust resistance genes in a single variety of wheat—a process called pyramiding or stacking, and a technique that helped Borlaug's wheat varieties withstand rust's attack for so long. In particular, researchers are looking to stack multiple "major" or "seedling" resistance genes, which defend the plant against a specific pathogen at all stages of the host's growth. (See illustration.) "The goal is to provide cultivars with more than one [Ug99] resistance gene, hopefully three," says Rouse at the CDL. "It might slow down the virulence." The stacking of major resistance genes can also be done in tandem with pyramiding "adult" resistance genes. These confer only partial resistance to an infection, but in combination can offer good protection against multiple strains of rust and are remarkably durable, often lasting for decades before being overcome by fungal mutations.

But using traditional breeding strategies to pyramid resistance genes is time-consuming. In a typical wheat-breeding program, "from the first cross to the release of a variety, it's about eight to nine years," says James Anderson, the head of the wheat-breeding program at the University of Minnesota. And that's just to develop a strain that carries one gene of interest. To stack three, four, or even five rust-resistance genes can add several more years to that time line. At CIMMYT, Singh and his colleagues have been working for nearly a decade to breed varieties that have multiple adult resistance genes. So far, they've succeeded in developing several Ug99-resistant varieties; two are being grown in

Ethiopia and one in Kenya. While these new cultivars, especially the Kingbird variety in Kenya, offer decent protection from stem rust, yields from those crops are not as high as Singh would like, and CIMMYT continues to test dozens of other candidate varieties that might be more attractive to farmers.

Grain yield and protein content tend to be a higher priority for growers than pathogen resistance, Anderson says. To develop a resistant strain that is appealing to growers, breeders must select for all of these qualities. As a result, "progress is still very slow to have a full scope of resistance [to Ug99]," says Jin. "Breeders are moving toward that, but they can't put all of their resources into a single strain of disease."

A more expeditious route to stacking is to develop a chunk of chromosome, called a cassette, containing several resistance genes that could be manually introduced into the wheat genome. Last year, Peter Dodds of the Commonwealth Scientific and Industrial Research Organisation (CSIRO) in Australia and colleagues, as well as another group led by Dubcovsky at UC Davis, took the first step toward genetically engineering a rust-resistant plant in this way. They cloned, for the first time, two major stem-rust resistance genes: Sr33 and Sr35, respectively.3,4 The work was a breakthrough in stem-rust research. "We went to the moon in 1969," says Dubcovsky. "We didn't have a single [major] resistance gene cloned for wheat, not a single one, until 2013."

Both Sr33 and Sr35 are involved in recognizing the presence of the fungus and sounding the wheat plant's immune alarm. (See illustration.) Dodds plans to use new gene-targeting techniques, such as TALENs and CRISPRs, to piece together both genes and others being cloned now into a single cassette that can be engineered into wheat plants. By inserting all the genes as a block—rather than as independent insertions dispersed on separate chromosomes—breeders can more easily select for those plants that carry the entire set.

Genetic engineering would also make it easier to pull in genes from wild relatives, a rich source of Ug99 resistance, without dragging along potentially unappealing agronomic qualities. (See "Wild Relatives," The Scientist, June 2014.) "We're looking at germ plasm, old varieties, [and] wild relatives [for resistance genes]," says Maricelis Acevedo, a wheat researcher at North Dakota State University who has identified a Ug99 resistance gene, called SrWLR, in an old wheat variety grown in Iran.5 "There's so much diversity there that has not been utilized."

At the University of Minnesota, Steffenson is on a similar mission, traveling the world over to find traits in wild grasses that might be beneficial to farmers. He brings plants back to St. Paul and raises them in grow rooms just around the corner from the Cereal Disease Laboratory's biosafety greenhouse where researchers experiment with Ug99. One room contains rows of goatgrasses (*Aegilops* sp.), unremarkable-looking plants with a stunning ability to resist rust infection. In his analysis of one species, *Aegilops sharonensis*, Steffenson found that 82 percent of the samples were resistant to Ug99; 97 percent of plants of another species, *Aegilops longissima*, were resistant; and all samples of a third species, *Aegilops speltoides*, remained healthy despite rust exposure. "When you look at what wild crop relatives can contribute to cultivated species, it's just a phenomenal amount of allelic diversity," he says. Despite such enviable resistance, Aegilops grasses make terrible food crops. "We call it 'the model nonmodel organism,'" says the Sainsbury Laboratory's Wulff, who is working with Steffenson to understand how goatgrasses resist Ug99 infection. The goal is to isolate those defenses and bring them into wheat, while leaving behind Aegilops' less desirable agronomic traits.

Even if the researchers surmount the technical hurdles of isolating the resistance genes and inserting them into the wheat genome, they will undoubtedly face considerable hurdles in bringing the product to market. In addition to public resistance to GM crops in general, wheat faces its own particular challenges.

Despite the public's distaste for GM foods, especially in Europe, many genetically engineered products are already on the market. According to the International Service for the Acquisition of Agri-Biotech Applications, in 2013 the U.S. grew 70 million hectares of GM soybeans, cotton, canola, sugar beets, maize, and more. Brazil and Argentina together grew 65 million hectares of GM crops and Canada nearly 11 million. In total, some 175 million hectares of biotech crops, as they're often called, can be found in cultivation around the world, and crops with stacked traits engineered into their genomes occupy an increasing share of that land—27 percent in 2013, up from 21 percent in 2009. Nevertheless, not a single GM wheat plant is approved for human consumption.

Monsanto came close with its Roundup Ready wheat, engineered to tolerate the company's Roundup herbicide, but widespread opposition among farmers and the public forced the company to abandon the project in 2004. The downfall for GM wheat has been a lack of a market, says Brett Blankenship, a wheat farmer in Washington and a vice president at the National Association of Wheat Growers. In the Pacific Northwest, for instance, much of the wheat grown is exported to Asia—Japan and Taiwan, in particular—where "they are resistant to the presence of biotech traits," says Blankenship. If buyers won't accept GM wheat, then farmers won't grow it.

University of Minnesota's Anderson says GM corn and soybeans may have received more acceptance because they're often processed or fed to animals, whereas most wheat enters the human food stream. Some consumers fear that tinkering with crop genomes could reduce the nutritive value of food, introduce toxins, increase the use of pesticides, or propel our already heavily-processed diets further away from what nature provided. The spread of engineered DNA to unintended targets in the form of crop-adjacent wild plants is another concern, highlighted by the 2013 appearance on an Oregon farm of Roundup Ready wheat—the very variety Monsanto had jumped ship on a decade earlier.

Some GM-wary consumers also question whether GM crops actually deliver on the benefits that companies trumpet. Several months ago, for example, researchers reported that corn rootworm managed to topple Bt maize, a widely planted GM corn variety with supposed resistance to the pest. Opposition to transgenic crops may also stem from the fact that some GM plants, such as Bt maize, possess genes from bacteria. Singh says that one way to win over the heart (and appetite) of the public is to use wheat's own genes to genetically engineer resistance—a process called cisgenesis—rather than bringing in genetic material from other taxa.

But the prospect of GM wheat faces additional hurdles. Because the crop is regionally idiosyncratic—farmers in South Dakota use different varieties than those in Washington or Kansas, for instance—it is not possible to develop a single blockbuster variety that can be sold across the country. As a result, unlike corn and soybeans, which are primarily sold by agribusiness corporations, new wheat varieties for local farmers have primarily come from academic breeders, and universities can rarely afford the expense of regulatory review by the multiple government agencies that approve GM crops. "In the public sector, we cannot release transgenics because we cannot afford the regulatory costs," says Dubcovsky.

Nevertheless, GM wheat may still make its debut. In 2010, Monsanto announced that it was re-entering the field of biotech wheat and would work to genetically engineer crops that are higher yielding, stress tolerant, or herbicide resistant. In the U.K., scientists at Rothamsted Research are engineering wheat plants to produce an aphid repellent odor, (E)-β-farnesene, using a "gene gun" that fires DNA into plant cells. And this past March, India gave the OK to several companies to pursue field trials of genetically engineered crops, including wheat. Wheat growers are also starting to come around to the idea of cultivating GM plants. Several years ago, the National Association of Wheat Growers and US Wheat Associates expressed their support of biotech wheat. "We just have to prepare ourselves for a future where GM crops are more accepted," Wulff says.

Until such a time, however, wheat scientists agree that, while it may take more time, conventional breeding does work in the long run. Through such methods, for example, Dubcovsky has been able to stack two resistance genes into wheat that protect the crop against stripe rust, which destroyed about a quarter of the wheat grown in California in 2003. Conventional breeding “has been effective,” says Dodds at CSIRO. “It’s an approach that’s worked for a long time. We grow wheat.”

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Freezing blueberries improves antioxidant availability

South Dakota State University. ScienceDaily. July 22, 2014

Blueberries pack a powerful antioxidant punch, whether eaten fresh or from the freezer, according to South Dakota State University graduate Marin Plumb.

Anthocyanins, a group of antioxidant compounds, are responsible for the color in blueberries, she explains. Since most of the color is in the skin, freezing the blueberries actually improves the availability of the antioxidants.

The food science major from Rapid City, who received her bachelor's degree in December, did her research as part of an honors program independent study project.

"Blueberries go head to head with strawberries and pomegranates in antioxidant capacity," said professor Basil Dalaly, Plumb's research adviser. In addition, blueberries are second only to strawberries, in terms of the fruits Americans prefer.

Blueberries are beneficial for the nervous system and brain, cardiovascular system, eyes and urinary tract, Dalaly explained. "Some claim it's the world's healthiest food."

The United States produces nearly 84 percent of the world's cultivated blueberries, an estimated 564.4 million pounds of blueberries in 2012, according to the Agricultural Marketing Resource Center.

Since blueberries are frozen soon after they are picked, "they are equal in quality to fresh," Plumb explained. She analyzed the anthocyanin content of blueberries frozen for one, three and five months and found no decrease in antioxidants over fresh berries.

The leaching that occurs from freezing actually increased the anthocyanin concentration, noted Plumb. "The ice crystals that form during freezing disrupt the structure of the plant tissue, making the anthocyanins more available."

Antioxidants, such as anthocyanins, eliminate free radicals, which are produced through common biological reactions within the body and outside factors such as the sun, pesticides and other pollutants, Dalaly explained. If left to roam free, these free radicals can attack DNA, proteins and lipids resulting in cellular changes that lead to development of diseases such as cancer.

"They have a domino effect," Dalaly said. "That is why we need to consume at least seven to nine servings of fruits and vegetables a day."

He teaches a course on phytochemicals -- the naturally-occurring chemical compounds in fruits and vegetable, many of which have the potential to boost the immune system and impact diseases, such as cancer and heart disease. His advice is simple: "the greener, or redder, the better."

Plumb called her undergraduate research project "a very good experience,' noting that she learned to both ask and answer questions such as "why is this happening this way?" One of the surprises was that she had to use blueberries from Canada and Argentina because they were in season when she did her experimental work.
Plumb concluded: "Blueberries are a great food, very good for you."

New hope for powdery mildew resistant barley
University of Adelaide. ScienceDaily. July 25, 2014

New research at the University of Adelaide has opened the way for the development of new lines of barley with resistance to powdery mildew.
In Australia, annual barley production is second only to wheat with 7-8 million tonnes a year. Powdery mildew is one of the most important diseases of barley.
Senior Research Scientist Dr Alan Little and team have discovered the composition of special growths on the cell walls of barley plants that block the penetration of the fungus into the leaf.
The research, by the ARC Centre of Excellence in Plant Cell Walls in the University's School of Agriculture, Food and Wine in collaboration with the Leibniz Institute of Plant Genetics and Crop Plant Research in Germany, will be presented at the upcoming 5th International Conference on Plant Cell Wall Biology and published in the journal New Phytologist.
"Powdery mildew is a significant problem wherever barley is grown around the world," says Dr Little. "Growers with infected crops can expect up to 25% reductions in yield and the barley may also be downgraded from high quality malting barley to that of feed quality, with an associated loss in market value.
"In recent times we've seen resistance in powdery mildew to the class of fungicide most commonly used to control the disease in Australia. Developing barley with improved resistance to the disease is therefore even more important."
The discovery means researchers have new targets for breeding powdery mildew resistant barley lines.
"Powdery mildew feeds on the living plant," says Dr Little. "The fungus spore lands on the leaf and sends out a tube-like structure which punches its way through cell walls, penetrating the cells and taking the nutrients from the plant. The plant tries to stop this penetration by building a plug of cell wall material -- a papillae -- around the infection site. Effective papillae can block the penetration by the fungus.
"It has long been thought that callose is the main polysaccharide component of papilla. But using new techniques, we've been able to show that in the papillae that block fungal penetration, two other polysaccharides are present in significant concentrations and play a key role.
"It appears that callose acts like an initial plug in the wall but arabinoxylan and cellulose fill the gaps in the wall and make it much stronger."
In his PhD project, Jamil Chowdhury showed that effective papillae contained up to four times the concentration of callose, arabinoxylan and cellulose as cell wall plugs which didn't block penetration.
"We can now use this knowledge find ways of increasing these polysaccharides in barley plants to produce more resistant lines available for growers," says Dr Little.

GSAD and Plant rDNA database: Two open platforms with plant cytogenetic information
University of Barcelona, ScienceDaily. July 25, 2014

Having cytogenetic information about plants is basic to classify species and promote new studies on agriculture and crop improvement. This is the main objective of two online platforms that collect chromosome information and provide it to the scientific community. The platforms have been developed by the EtnoBioFic Research Group, composed by experts from the Botany Laboratory of the Faculty of Pharmacy of the University of Barcelona (affiliated with CSIC), the Botanical Institute of Barcelona (IBB-CSIC-ICUB), and Paris-Sud University (France).

Plant rDNA Database is the first database that collects information about the position of genes that codify plant ribosomal DNA (DNAr). The website Genome Size in Asteraceae Database (GSAD) is an exhaustive catalogue of genome size data for one of the largest and economically important Angiosperm families: Asteraceae.

Name, position and organization of ribosomal DNA genes (5S and 18S-5.8S-26S) in chromosomes are characteristic of a certain species, genus or group of plants. Therefore, this information is completely useful for basic research, genotype study, evolutionary biology and crop improving programmes. "By consulting this website, researchers can know if there is any published result about any taxonomic group and access to a catalogue that enables to analyse and compare data" explains Sònia Garcia, researcher from the Botany Laboratory of the Faculty of Pharmacy and member of the EtnoBioFic Research Group.

The database about ribosomal DNA was obtained from more than 600 scientific papers about plant molecular cytogenetics. "More than 50% of papers indexed at the database have been published for the last ten years; that proves that there is an increasing interest in this information and a need for compilation," affirms Sònia Garcia. "To date -- adds the researcher -- , it was so difficult to find these data as they were scattered in many publications." The data base includes information about DNAr gene localization of angiosperms, gymnosperms, bryophytes and pteridophytes.

The portal GSAD includes data about the genome size of about 1,200 Asteraceae species, one of the largest families of angiosperms, collected from 133 scientific papers. The family Asteraceae is worldwide distributed, except in the Antarctica. It includes around 25,000 species; some of them are economically important, for instance: sunflowers, lettuces, artichokes and chrysanthemums. It is the first database that gathers this type of information about this plant family.

Evolutionary genetics comparative studies with living beings use genome size and the total amount of nuclear DNA to evaluate the cost of sequencing programmes. "GSAD provides researcher with direct information, so they do not have to look for it in numerous publications," points out Garcia. "Therefore, double efforts are avoided, knowledge gaps are more easily detected and the aspects about Asteraceae genome studies that arouse more interest are identified," she concludes.

These two tools provided to the international scientific community emerge from the research developed by EtnoBioFic Research Group, led by Professor Joan Vallès, from the Department of Natural Products, Plant Biology and Edaphology of UB and the Botany Laboratory of the Faculty of Pharmacy, and by Teresa Garnatje, researcher at the Botanical Institute of Barcelona (IBB-CSIC-ICUB). The group is mainly interested in understanding the evolutionary history of different plant groups as well as their genome evolution and the processes involved in it. Besides cytogenetic studies, the group also develops studies focused on phylogenetics and phylogeography. Its research lines are also based on the study of the history of botany and ethnobotanical research; in other words, it develops studies about the relationships between people and plants and also on the traditional knowledge about plants -- particularly in the Catalan language territories. They are mostly conducting ethnofloristic works, with emphasis in medicinal and food plant uses.

Platforms websites:

Plant rDNA Database:

http://www.plantrdnadatabase.com/

Genome Size in Asteraceae Database (GSAD):

http://www.asteraceaegenomesize.com

Genetic moderation is needed to debate our food future

New Scientist. 28 July 2014 by Susan Watts

GM is now a term loaded with baggage. Scientists must allow for people's objections to show the public there's nothing "spooky" about it.

With food security firmly on the international agenda, there's a growing appetite to look again at the opportunities promised by agricultural biotechnology.
Scientists working in this area are excited by new techniques that enable them to edit plant DNA with unprecedented accuracy. Even epigenetic markers, which modulate the activity of genes, can now be altered. The promise is to modify crops to make them more nutritious or resistant to disease.
But there's a problem, notably in Europe: genetic modification.
Much of agricultural biotechnology – including conventional breeding – involves genetic modification of one kind or another. But "GM" has come to mean something quite specific, and is loaded with baggage. To many people it means risky or unnatural mixing of genes from widely disparate species, even across the plant and animal kingdoms, to create hybrids such as corn with scorpion genes.
That baggage now threatens to undermine mature debate about the future of food production.
It is no longer a simple yes/no choice between high-tech agribusiness and conventional production driven by something ill-defined as more "natural".
The battle lines of this latest wave of agricultural advance are already being drawn. The UK's Biotechnology and Biological Sciences Research Council, for example, is working on a position statement on the new technologies, which it expects to release later this summer.
It is clear that, over the coming years, the general public will have to decide which of these technologies we find acceptable and which we do not.
So where did it all go wrong to begin with?
In the late 1990s, when I was reporting on early GM research for the BBC's current affairs programme Newsnight, anti-GM protestors realised that vivid images made good TV and rampaged through fields in white boiler suits destroying trial crops.
On the other side, industry representatives brushed aside public concerns and tried to control the media message, thumping the table in the office of at least one bemused newspaper editor (who went on to co-script a TV drama about a darker side to GM). They also lobbied hard for the relaxation of regulations governing agribusiness.
In the middle was the public, just coming to terms with farming's role in the BSE crisis. There was little space for calm, rational debate. Instead, GM became the cuckoo in the nest of agricultural biotechnology and its industry backers became ogres, shouting down any discussion of alternatives.
As a result, many people remain unaware that there are other high-tech ways to create crops. Many of these techniques involve the manipulation of genes, but they are not primarily about the transfer of genes across species.
But for GM to be discussed alongside such approaches as just another technology, scientists will have to work harder to dispel the public's remaining suspicions.
I recently chaired a debate on biotech at the UK's Cambridge Festival of Plants, where one audience member identified a public unease about what he called the slightly "spooky" aspect of GM crops. He meant those scorpion genes, or fish genes placed into tomatoes – the type of research that helped to coin the phrase "yuck factor".
To my surprise, a leading plant scientist on the panel said she would be prepared to see cross-species manipulation of food crops put on hold if the public was overwhelmingly uncomfortable with it. Ottoline Leyser, director of the University of Cambridge's Sainsbury Laboratory, said she believed valuable GM crop development could still be done even if scientists were initially restricted to species that can swap their genes naturally, outside of the laboratory. An example of this might be adding a trait from one variety of rice to another.
Nevertheless, Leyser remains adamant that there is "nothing immensely fishy about a fish gene". What's more, she added, the notion of a natural separation between species is misplaced: gene-swapping between species in the wild is far more prevalent than once thought.
But Leyser insisted that scientists must respect the views of objectors – even if "yuck" is their only complaint. That

concession from a scientist is unusual. I've spoken to many of her peers who think such objections are irrational.

Scientists cannot expect people to accept their work blindly and they must make time to listen. Above all, more of them should be prepared to halt experiments that the public is uncomfortable with. And it's beginning to happen.

Paul Freemont is co-director of the Centre for Synthetic Biology and Innovation at Imperial College London. He designs organisms from scratch but would be prepared to discontinue projects that the public is unhappy about. He says scientists need an occasional reality check.

"We are going to have to address some of the consequences of what we're doing, and have agreements about what's acceptable to society in terms of manipulating biology at this level," Freemont says.

Scientists funded with public money may already feel some obligation to adopt this approach. But those working in industry should consider its advantages too. A more open and engaged conversation with the public could surely benefit the companies trying to sell us novel crop technologies.

Society, for its part, will need to listen to the experts with an open mind. And as we work out how to feed an expanding population, we will need to ask questions that are bigger than "GM: yes or no?"

Saving seeds the right way can save the world's plants

Source: National Institute for Mathematical and Biological Synthesis (NIMBioS). ScienceDaily. July 30, 2014

Exotic pests, shrinking ranges and a changing climate threaten some of the world's most rare and ecologically important plants, and so conservationists establish seed collections to save the seeds in banks or botanical gardens in hopes of preserving some genetic diversity.

For decades, these seed collections have been guided by simple models that offer a one-size-fits-all approach for how many seeds to gather, such as recommending saving 50 seed samples regardless of species' pollination mode, growth habitat and population size.

A new study, however, has found that more careful tailoring of seed collections to specific species and situations is critical to preserving plant diversity. Once seeds are saved, they can be reintroduced for planting in suitable locations if conditions are favorable.

In the study, researchers from the National Institute for Mathematical and Biological Synthesis and the University of Tennessee used a novel approach called simulation-based planning to make several new sampling recommendations, confirming that a uniform approach to seed sampling is ineffective.

First, collectors must choose their plant populations from a wide area rather than a restricted one. Sampling widely can capture up to nearly 200 percent more rare genes than restricted sampling. In addition, in most situations, collecting from about 25 maternal plants per population versus 50 plants appears to capture the vast majority of genetic variation. The study also showed that for many species, collecting more than eight to ten seeds per plant leads to high overlap in genetic diversity and would thus be an excess of effort.

Increasing concerns over agriculture and food security as well as an increasing recognition of how fast biodiversity is disappearing has prompted seed banks to ramp up their collections. By the same token, botanic gardens that were once more focused on showcasing plants are now increasingly having a conservation mission too, according to the study's lead author Sean Hoban, a postdoctoral fellow at NIMBioS.

"Our approach can be used to further refine seed collection guidelines, which could lead to much more efficient and effective collections, allowing us to preserve more diversity of the world's plants. These collections could benefit future ecosystem restoration projects as well as improve agricultural and forestry efforts," Hoban said.

Hoban and his colleagues are now working on ways to custom-tailor seed collections to particular species' dispersal, mating system and biology.

Journal Reference: Sean Hoban, Scott Schlarbaum. Optimal sampling of seeds from plant populations for ex-situ conservation of genetic biodiversity, considering realistic population structure. Biological Conservation, 2014; 177: 90 DOI: 10.1016/j.biocon.2014.06.014

Water 'thermostat' could help engineer drought-resistant crops

Source: ScienceDaily from Duke University. August 27, 2014.

Duke University researchers have identified a gene that could help scientists engineer drought-resistant crops. The gene, called OSCA1, encodes a protein in the cell membrane of plants that senses changes in water availability and adjusts the plant's water conservation machinery accordingly.

"It's similar to a thermostat," said Zhen-Ming Pei, an associate professor of biology at Duke.

The findings, which appear Aug. 28 in the journal Nature, could make it easier to feed the world's growing population in the face of climate change.

Drought is the major cause of crop losses worldwide. A dry spell at a crucial stage of the growing season can cut some crop yields in half.

Water shortages are expected to become more frequent and severe if climate change makes rainfall patterns increasingly unreliable and farmland in some regions continues to dry up. Coupled with a world population that is expected to increase by two billion to three billion by 2050, researchers worldwide are looking for ways to produce more food with less water.

Some researchers hope that genetic engineering -- in addition to improved farming practices and traditional plant breeding -- will add to the arsenal of techniques to help crops withstand summer's swelter. But engineering plants to withstand drought has proven difficult to do, largely because plants use so many strategies to deal with dehydration and hundreds of genes are involved.

The problem is confounded by the fact that drought is often accompanied by heat waves and other stresses that require different coping strategies on the part of the plant, Pei said.

One way that plants respond to water loss is by boosting the levels of calcium within their cells. The calcium surge acts as an alarm signal that triggers coping mechanisms to help the plant rebalance its water budget. But until now, the molecular machinery that plants use to send this signal -- and monitor water availability in general -- remained unknown.

Pei and Duke colleagues Fang Yuan, James Siedow and others identified a gene that encodes a protein in the cell membranes of plant leaves and roots, called OSCA1, which acts as a channel that allows calcium to surge into the cell in times of drought.

The gene was identified in *Arabidopsis thaliana*, a small unassuming plant related to cabbage and canola that is the lab rat of plant research.

Plants with defective versions of the calcium channel don't send an alarm signal under water stress like normal plants do.

When the researchers grew normal plants and plants with defective versions of the gene side by side in the same pot and exposed them to drought stress, the mutant plants experienced more wilting.

The findings could lead to new ways to help plants thrive when water is scarce.

The team's next step is to manipulate the activity of the OSCA1 gene and related genes and see how those plants respond to drought -- information that could lead to crops that respond more quickly and efficiently to dehydration.

"Plants that enter drought-fighting mode quickly and then switch back to normal growth mode quickly when drought stress is gone should be able to allocate energy more efficiently toward growth," Pei said.

Journal Reference: Fang Yuan, Huimin Yang, Yan Xue, Dongdong Kong, Rui Ye, Chijun Li, Jingyuan Zhang, Lynn Theprungsirikul, Tayler Shrift, Bryan Krichilsky, Douglas M. Johnson, Gary B. Swift, Yikun He, James N. Siedow, Zhen-Ming Pei. OSCA1 mediates osmotic-stress-evoked Ca2 increases vital for osmosensing in Arabidopsis. Nature, 2014; DOI: 10.1038/nature13593

If trees could talk: Forest research network reveals global change effects
Source: Smithsonian Tropical Research Institute via ScienceDaily. September 26, 2014

Permafrost thaw drives forest loss in Canada, while drought has killed trees in Panama, southern India and Borneo. In the U.S., in Virginia, over-abundant deer eat trees before they reach maturity, while nitrogen pollution has changed soil chemistry in Canada and Panama. Continents apart, these changes have all been documented by the Smithsonian-led Center for Tropical Forest Science-Forest Global Earth Observatory, CTFS-ForestGEO, which released a new report revealing how forests are changing worldwide.
"With 107 collaborators we've published a major overview of what 59 forests in 24 countries, where we monitor nearly 6 million trees teach us about forest responses to global change," said Kristina Anderson-Teixeira, first author of the report and CTFS-ForestGEO and ecosystem ecologist based at the Smithsonian Conservation Biology Institute.
Many of the changes occurring in forests worldwide are attributable to human impacts on climate, atmospheric chemistry, land use and animal populations that are so pervasive as to warrant classification of a new geologic period in Earth's history -- the Anthropocene, the Age of Humans.
Measuring and understanding the effects of all these changes -- collectively termed "global change" -- are easier said than done. Some of the best information about these global-scale changes comes from CTFS-ForestGEO, the only network of standardized forest-monitoring sites that span the globe.
Since the censuses began at the first site on Barro Colorado Island in Panama in 1981, atmospheric carbon dioxide has increased by 16 percent. The forest sites in the network have warmed by an average of over 1 degree F (0.6 degree C) and experienced up to 30 percent changes in precipitation. Landscapes around protected sites experience deforestation.
The plot network now includes forests from Brazil to northern Canada, from Gabon to England and from Papua New Guinea to China.
In addition to identifying, mapping, measuring and monitoring trees, researchers describe the relatedness of trees, track flower and seed production, collect insects, survey mammals, quantify carbon stocks and flows within the ecosystem, take soil samples and measure climate variables like rainfall and temperature. The thorough study of these plots provides insights into not only how forests are changing but also why.
Climate change scenarios predict that most of these sites will face warmer and often drier conditions in the future -- some experiencing novel climates with no modern analogs. Forests are changing more rapidly than expected by chance alone, and shifts in species composition have been associated with environmental change. Biomass increased at many tropical sites across the network.
"It is incredibly rewarding to work with a team of forest scientists from 78 research institutions around the world, including four Smithsonian units" Anderson-Teixeira said. "CTFS-ForestGEO is a pioneer in the kind of collaborative effort it takes to understand how forests worldwide are changing."
"We look forward to using the CTFS-ForestGEO network to continue to understand how and why forests respond to change, and what this means for the climate, biodiversity conservation and human well-being," said Stuart Davies, network director.
Journal Reference: Anderson-Teixeira, K.J., Davies, S.J., Bennett, A.C., et al. CTFS-ForestGEO: A worldwide network monitoring forests in an era of global change. Global Change Biology, 2014.

Bacteriophage Boom?
By Jyoti Madhusoodanan. The Scientist. September 29, 2014

Researchers are putting a fresh crop of phage-based products to agricultural and

medical use, on farms and in early-stage clinical trials.
The search for alternatives to antibiotics has led many scientists to a treatment practice that's been on the fringes of modern medicine for nearly a century. Bacteriophages—viruses that infect and kill bacteria—were first used in 1919 to treat a wide range of infections.
Phage therapy fell out of favor with the advent of antibiotics; the practice has only persisted in some European countries as an experimental treatment. However, earlier this year, phage therapy was highlighted as one of seven approaches to "achieving a coordinated and nimble approach to addressing antibacterial resistance threats" in a 2014 status report from the National Institute of Allergy and Infectious Diseases (NIAID).
Classically, the treatment uses a bacteriophage, or cocktail of several phages, to specifically lyse target pathogenic bacteria. Researchers and biotech companies continue to refine this method, but in the absence of clear regulatory and manufacturing practices—and potential profits—phage therapy has yet to become mainstream for "the same reason many big companies have gotten out of making new antibiotics," said microbiologist Jason Gill of Texas A&M University. "The development costs are the same as for any other drug, but the profits are not as high as you might make from a new kind of [cholesterol] drug."
Still, other scientists have honed in on the bactericidal enzymes or tactics used by phages to identify potential small-molecule antibacterial drugs. And beyond human medicine, phage therapies have been successfully commercialized for use in farms and on food products. Their success—or failure—in these other applications hint at the road ahead for clinical phage therapy.
"All [phages] do is interact with and parasitize the bacteria, so we can learn from them exactly how they do this, and identify a number of different Achilles' heels of the bacteria," said microbiologist Raymond Schuch of Rockefeller University in New York City.
Renewed interest in phage therapy is due in part to the growing problems posed by antibiotic overuse in the clinic, which has escalated microbial resistance. But even when antibiotics are overprescribed, most people only receive doses in response to illness.
On farms, however, small amounts of antibiotics are routinely used to promote animal growth or prevent disease outbreaks; the practice has been linked to long-term changes to animals' commensal microbiomes, increased transfer of antibiotic-resistant bacteria from animals to farmworkers, and potential risks to human health. Recent governmental initiatives to curb antibiotic use have largely overlooked their use on farms. But a small number of phage-based alternatives are now available from Maryland-based biotech Intralytix, which manufactures sprays that target Listeria, Salmonella, and E. coli O157:H7 in foods and food-processing facilities.
"To get phages approved for food safety uses wasn't actually very difficult," said Gill, who is not involved with the company. "Maybe the regulatory issues [with clinical use] won't be as big a hurdle as we think but it's not something we know much about right now."
Scientific clarity—understanding why and how to design phage treatments—is a higher priority, according to Gill. In a 2006 Antimicrobial Agents and Chemotherapy study, he and his colleagues attempted to use phages to treat bovine mastitis caused by Staphylococcus aureus, a growing concern in the dairy industry. However, only 16 percent of cows treated were cured. High phage concentrations in milk up to 36 hours after treatment also suggested that the virus was being inactivated or destroyed within the gland. "Not every bacterial infection is going to be equally successfully treated with phage therapy," said Gill.
The work highlights one of its many quirks: viruses that look like efficient killers in experiments can fail to cure an infection in the field. Phages may work better at targeting subsets of infections, such as on the skin or deep within organs. Even when bacteriophage therapy is successful, scientists know little about the underlying mechanisms.

"We don't have a good feel for how phage and bacteria interact within a host to know for sure why one phage [might] work better than the other," said Gill. "As we move on, we'll find that some pathogens and some infections respond well to phage therapy and others don't."

Ear and lung infections caused by S. aureus or *Pseudomonas aeruginosa*, a major concern for cystic fibrosis patients, may be viable targets for clinical phage therapy, according to results from early Phase 1 and 2 clinical trials. In a 2009 Clinical Otolaryngology study, researchers treated 24 patients suffering chronic middle-ear infections caused by antibiotic-resistant P. aeruginosa with Biophage-PA, a mixture of six phages, and found significant improvement compared to a placebo.

Another pulmonary pathogen, *Burkholderia cenocepacia*, was successfully targeted by phage in a mouse model of lung disease. The results, published in a 2010 paper in The Journal of Infectious Diseases by Gill and his colleagues, found that in this case, administering phages intraperitoneally treated the disease better than an intranasal spray.

Bone wounds and prosthetic infections, where bacterial biofilms can fester, are another attractive target for potential phage therapy, according to pathologist Catherine Loc-Carillo at the University of Utah. Osteomyelitis caused by drug-resistant bacteria, among other diseases "where we are almost out of antibiotic options are the highest priority [for phage therapy]," she said.

In an alternative approach, other researchers are trying to derive broad-spectrum molecules by understanding how phages kill their hosts. In a 2013 PLOS ONE study, Rockefeller University researchers identified how phage lysins killed *Bacillus anthracis* by targeting an enzyme essential to cell wall formation in the pathogenic bacteria. They then identified a small-molecule inhibitor that mimicked the interaction of the phage with its host. Found effective against several Gram positive pathogens, the molecule, Otsuka Pharmaceutical's Epimerox, is currently being tested as a potential therapeutic.

"We learned how phage lysins kill the bacteria and came up with a way [to mimic that]," said Schuch, who coauthored the study. "We exploited the interaction that takes place between the bacteria and the phage to identify a new target for bacterial drug development."

Both strategies—using small-molecule phage mimics and mixing up cocktails of viral particles—are being employed by biotech firms hoping to commercialize the treatments. For example, Richmond, Virginia-based AmpliPhi reported preclinical studies for phages targeting at least three kinds of bacteria in 2012 and 2013, while Bangalore, India-based GangaGen is conducting Phase 2 clinical trials to decolonize nasal *S. aureus* using its StaphTAME.

However, until both manufacturing and regulatory processes are more clearly defined, the near-term future of phage therapy is likely to be in "personalized, sort of boutique experimental treatments"—where traditional therapies have failed—Loc-Carillo explained.

Early attempts at phage therapy were conducted in an enthusiastic time, when little was understood about the viruses themselves. "Bacteriophage therapy will have its day again," said Loc-Carillo. "It sort of had one, before antibiotics came along, but it wasn't well understood then. Now, scientists are more intrigued by the complexity of it than just falling in love with an idea."

Forthcoming meetings

GLOBAL BIOTECHNOLOGY CONGRESS 2015

July 22nd – 25th, 2015, Boston, USA

After the success of “Global Biotechnology Congress 2014” the “Global Biotechnology Congress 2015” will be held in Boston, USA, from July 22nd – 25th, 2015. This event aims to highlight the translational nature of modern biotechnological research, with emphasis on both basic and applied science. Presentations would focus among others on pharmaceutical biotechnology, vaccines, CNS, cancer, antibodies, protein engineering, plant and environmental biotechnology, transgenic plants and crops, bioremediation, microbial diversity, business development, strategic alliances, partnering trends, product opportunities, growth business models, strategies, and licensing in biotechnology.

The principal goal of this conference will be to present some of the latest outstanding breakthroughs in Biotechnology, to bring together both young and experienced scientists from all regions of the world, and to open up avenues for research collaborations at regional and global level.

Prof. Ferid Murad (Nobel Laureate) and Prof. Atta-ur-Rahman, FRS are the conference Co-Presidents. To date several Nobel Laureates and other eminent scientists have shown a keen interest to present Plenary and Keynote Lectures at the event.

There will be sessions in all major areas of biotechnology as given below:

1. Pharmaceutical Biotechnology: Biopharmaceuticals discovery (CNS, cancer, cardiovascular, endocrine, immune); vaccines; antibodies; protein engineering.
2. Plant and Environment: Transgenic plants and crops; bioremediation; microbial diversity; bio-monitoring; photosynthetic microorganisms, cyanobacteria and microalgae; genomics-assisted breeding.
3. Industrial and Manufacturing: Bio-fuels; energy crops (cellulosic ethanol industry); industrial enzymes; bioprocess engineering and optimization.
4. Medical Biotechnology: Biopharmaceutical manufacturing; diagnostics; imaging; pharmacogenomics (personalized medicine); microarray technology; biomarkers.
5. Business Development: Strategic alliances; partnering trends; product opportunities; growth; business models and strategies; licensing; merger and acquisitions; outsourcing; venture capital and financing; intellectual property.
6. Regenerative Medicine: Stem cells, gene therapy; tissue engineering; cell based therapy; cell cultivation.
7. Marine Biotechnology: Environment applications of marine biotechnology; marine natural products; bioproducts and bioactive compounds; marine microbiology and biodiversity; marine-based drug discovery & development; genomics and proteomics of marine organisms; aquatic microbial ecology.
8. Other Areas: Food; marine; bio-safety; systems biology, clinical research/clinical trials; bioethics; nanobiotechnology.

DEADLINE FOR ABSTRACT SUBMISSION: 31st January, 2015

E-mail: abstractsubmissions@globalbiotechcongress.com

Web: http://biotechnology-conference.us/

Plant Biology Scandinavia 2015 - the 26th Congress of the Scandinavian Plant Physiology Society

Stockholm, Sweden, 9-13 August 2015.

The SPPS congress is an excellent forum for useful exchange of ideas and scientific data between plant biologists, researchers and students from Scandinavia and the rest of the world. The congress welcomes everyone interested in plant biology.

The programme offers the following sessions:

Opening session- From the lab. to the field
Development
Epigenetics and gene regulation
High throughput biology
Photobiology
Abiotic stress
Biotic interactions
Education and outreach
Registration and Abstract Submission Opens February 2015
Early bird deadline 30 April 2015
More info: http://spps2015.org/

3rd Global Moringa Meet 2014
Jaipur, India
November 21 & 22, 2014
Web:
http://jatrophaworld.org/global_moringa_meet_81.html

Plant Transport 2014 - Systems and Synthetic Biology
Glasgow, Scotland
December 5-7, 2014
Web: http://ptm.psrg.org.uk

The second Adam Kondorosi Symposium, Frontiers in Legume Biology.
Gif-sur-Yvette, Paris, France
December 11-12, 2014
Web: http://www.isv.cnrs-gif.fr/colloque-AK2014/

Plant Lipids: Structure, Metabolism & Function - Integration of Lipid Metabolism, Signaling and Engineering
Galveston, TX (U.S.A.)
February 1-6, 2015
Web:
http://www.grc.org/programs.aspx?id=13965

Agriculture and Climate Change - Adapting Crops to Increased Uncertainty
Amsterdam. Holanda
February 15-17, 2015
More Information:
http://www.epsoweb.org/event/agriculture-and-climate-change-adapting-crops-increased-uncertainty-15-17-february-2015-nh-gra

2015 Spring International Conference on Agriculture and Food Engineering (AFE-S)
Beijing, China
April 14 to 16, 2015
Web:
http://www.engii.org/scet2015/Home.aspx?utm_campaign=afe&utm_source=e_cp&utm_medium=conf_scet_afe_20140905_cfp

International Symposium on Protein Crops
MBG-CSIC
Pontevedra, Spain
May 4- 7, 2015
Web: www.symposiumproteincrops.org

The 3rd Plant Genomics Congress
London (U.K.)
May 11- 12, 2015
Web: http://www.globalengage.co.uk/plantgenomics.html

10th International Congress on Plant Biotechnology and Agriculture (BioVeg 2015)
Ciego de Ávila, Cuba. May 11–15, 2015
Web:
http://bioveg.bioplantas.cu/default.aspx

Plant Metabolic Engineering. Harnessing Plant Metabolism for the Bio-Based Economy
Waterville Valley, NH (U.S.A.)
July 19-24, 2015
Web:
http://www.grc.org/programs.aspx?id=13310

SEB Prague 2015
Prague, Czech Republic
30th June - 3rd of July 2015
Web:
http://www.sebiology.org/meetings/Prague/Prague2015.html

Positions available

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Tenure track position in Plant Systems Biology at McGill University
McGill University, Quebec (Canadá)

Applications are invited for a tenure-track position at the rank of Assistant/Associate Professor in the Plant Systems Biology area of specialization. The successful candidate is expected to follow an integrated systems-biology approach in developing a strong independent research program that will study the metabolic response of plants to growth conditions and stresses and/or will identify the biomarkers for use in crop improvement programs aimed at increasing yield and quality of plant products for food production. Qualifications include: a Ph.D. in plant science, plant molecular biology, biochemistry or a related discipline; outstanding post-doctoral experience in metabolomics or metabolic engineering; and a demonstrated publication record in the use of such techniques for original plant-science applications. Expertise in phenomics and/or biostatistics is considered a complementary asset.
Candidates are expected to lead an externally funded research program and are encouraged to seek funding from government, industry, and competitive granting agencies. There must be a commitment to teaching at the undergraduate and graduate levels, and to the supervision of graduate students. Candidates are expected to serve on departmental, faculty and university committees, and participate in their professional societies. Collaboration with other researchers at McGill, as well as in the relevant university research centres is encouraged.
Applicants should submit by December 3, 2014, their curriculum vitae, statements of their research and teaching philosophies and the names, email addresses and telephone numbers of at least 3 professional references who can evaluate their candidacy, directly to:

Professor Pierre Dutilleul
Department of Plant Science
Faculty of Agricultural and Environmental Sciences
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21,111 Lakeshore Road
Ste-Anne-de-Bellevue, Quebec
Canada H9X 3V9
Tel 514-398-7870
Email: pierre.dutilleul@mcgill.ca
Letters of reference should be sent to Professor Pierre Dutilleul by December 3, 2014 as well.

Visiting Assistant Professor in Biology (Plant Ecology)
University of Puget Sound. Washington (U.S.A.)

Appointment: Full-time, 2-year visiting assistant professor; begins Fall Term 2015
Responsibilities:
We seek an ecologist who studies plants at any organizational level to teach at our undergraduate institution. Specifically, the visiting faculty member will teach an evolution and diversity of life introductory biology course, a sophomore-level ecology course, and an upper division elective in plant biology. A typical teaching load consists of two lecture classes and two lab sections, or one lecture class and three lab sections per semester. We prefer individuals who will undertake a research program that includes mentoring of undergraduate research students. Lab space and other resources are available.
Puget Sound offers a generous benefits package. For more information, visit:http://www.pugetsound.edu/about/offices--services/human-resources/overview-of-university-benefit/.
The University of Puget Sound is located in Tacoma, Washington, a vibrant, diverse mid-sized urban port city. Within, and near, Tacoma there is ready access to urban, rural, and natural areas as well as opportunities to participate in a wide variety of cultural activities.

Application Deadline: Search and selection procedures will be closed when a sufficient number of qualified candidates have been identified. Interested individuals are encouraged to submit application materials no later than January 12, 2015 to ensure consideration.

Reengineering Photosynthesis, Assistant, Associate or Full Professor, UIUC
University of Illinois at Urbana-Champaign. Illinois, U.S.A.

The School of Integrative Biology and the Department of Plant Biology at the University of Illinois, Urbana-Champaign seek an outstanding individual working in the broadly defined fields of bioengineering/synthetic biology/biochemistry, with interest in devising novel strategies and using cutting-edge technologies to improve photosynthetic performance and efficiency of plants. Research areas of interest in reengineering photosynthesis include, but are not limited to: carboxylation chemistry and redesign, synthetic assembly of new photosynthetic processes, installing microbial pathways into plants, and systems engineering of extant photosynthetic metabolism and pathways.
The successful candidate will be expected to develop an externally funded research program, teach at undergraduate and graduate levels, and collaborate with faculty to develop research and education initiatives in plant bioengineering and photosynthetic redesign. A Ph.D. or equivalent in a relevant field is required for appointment. For the Assistant Professor level postdoctoral experience is highly desirable. Appointment as an Associate or Full Professor requires credentials warranting tenure at the University of Illinois.
The appointment is for a full-time, nine-month Assistant (tenure-track), Associate or Full Professor (tenured). Target start date is 16 August 2015. Salary is commensurate with experience.
To ensure full consideration, please create your candidate profile through http://go.illinois.edu/Photosynthesis and upload your application letter, curriculum vitae, summary of research and plans, teaching philosophy and experience, and contact information including e-mail addresses for three professional references by 1 December 2014. After a review of the candidate's record, the search committee may then contact the applicant about soliciting letters of reference.

Post Doctoral Plant Molecular Biologist (RNAi Specialist)
Berkshire, England

Post Doctoral Plant Molecular Biologist (RNAi Specialist)
2 YEAR CONTRACT
A leading agrochemical company based in Berkshire is currently recruiting a Post Doctoral Scientist to join their RNAi team in the Herbicide Bioscience group. You will be ressponsible for providing expertise in biochemical, molecular biology and biokinetic analysis of herbicide chemistries to understand how their mode of action, potency, and kinetics influence the biological activity and spectrum.
Key Candidate Criteria:
- Post-Doc with extensive experience of working in a plant molecular biology laboratory;
- Deep knowledge of gene expression and gene silencing in plant species;
- Experience of developing and optimising assays to determine the level of gene silencing in a target tissue;
- Clear knowledge and experience of a wide range of RNAi techniques and applications;
- Use of confocal microscopy to detect uptake and movement of small RNAs;
- Experience of small RNA detection methods in plant species;
- Knowledge of the use of next-generation sequencing techniques in gene silencing research;
- Expertise in the use of techniques such as Q-PCR and nucleic acid preparation;
- Ability to effectively communicate with customers and colleagues across international research sites;
- An ability to work closely and effectively in a team environment and with the wider community must be demonstratet

If you have the skills and experience for this excellent opportunity, please apply online with your updated CV or contact Neil Robinson on 0161 868 2229 or at **neil.robinson@srg.co.uk** for further information.

Program Chair position in Biology
Westminster College. Salt Lake City. Utah, (U.S.A.)

Westminster College in Salt Lake City, Utah, invites applications for a Program Chair position in Biology. We are seeking a broadly-trained Plant Biologist, with an organismal focus, who would bring new course ideas and research models to a thriving program. The successful candidate will begin Fall semester 2015 and will have leadership skills and a strategic vision that capitalizes on our growing program and existing strengths.
Minimum Qualifications:
Ph.D. in Plant Biology or a related field
Rank of Associate or Full Professor
Significant teaching experience
Leadership experience
For a complete job posting including application instructions, please navigate to our online job board at https://jobs.westminstercollege.edu/

Postdoctoral Fellow
The Samuel Roberts Noble Foundation. Ardmore. Oklahoma. (U.S.A.)

The Forage Improvement Division of The Samuel Roberts Noble Foundation, Inc. is seeking applicants for the position of Postdoctoral Fellow. The Foundation has state-of- the-art research and greenhouse facilities, and modern laboratory and office areas. Research related to this position will be conducted in the laboratory of Dr. Carolyn Young. The incumbent will be responsible for duplication P. Omnivoracollection, pathogen assays, implementation of detection assay and evaluation of plots. The successful applicant will be primarily responsible for the design and implementation of experiments, data analysis and interpretation and publishing results in peer-reviewed journals.
This Postdoctoral Fellow position is funded through an internal research initiative. The Noble Foundation's Forage365 research initiative aims to provide a sustainable, year-round grazing system. Funding for this position will be available in January 2015. Funding is anticipated to be renewed annually based upon performance and funding availability and is scheduled to end on or before December 31, 2018.
Qualifications:
Applicants should have a PhD in plant pathology, mycology, plant biology or molecular biology with a strong background in plant microbe interactions and excellent written and verbal communication skills. Experience with field studies is preferred.
Application Instructions:
Applicants are requested to apply online by completing the application and submitting a resume, transcript(s), contact information for three references (excluding relatives), and a cover letter explaining interest in the position and career goals. If applicant does not have the ability to upload the additional documents they can be faxed to (580) 224-6240 (please include position number), but the application should be completed and submitted online.
Applications will be accepted until a candidate is hired. Interested applicants should apply immediately.
The Samuel Roberts Noble Foundation, Inc.
Human Resources Department
Position Number: FB-510
2510 Sam Noble Parkway
Ardmore, OK 7340
E-mail: NFHR@noble.org
Website: www.noble.org/

Post-Doctoral Research Associate Position in Soybean Abiotic Stress Genetic
University of Missouri. Columbia, Missouri, (U.S.A.)

A post-doctoral research associate position is available immediately at the Molecular Genetics and Soybean Genomics Laboratory at the University of Missouri. The primary responsibility of this person is to conduct abiotic stress QTL mapping and map-based cloning, develop

functional markers, and perform genomics-assisted selection to combine QTLs/genes for soybean plant tolerance to drought and flooding. The successful candidate will utilize modern whole genome approaches and techniques for QTL mapping and characterization. Applicants should have a Ph.D. in genetics, plant biology, or a related discipline. Experience in next generation sequencing, genome data mining, SNP marker development, and application to a breeding program is essential. Excellent oral and written communication skills and the ability to work well in a collaborative research environment are highly desirable.
Lab website:
http://soybeangenomics.missouri.edu

Applicants should provide a letter of interest, a complete CV, and three reference letters. Please include the following in the subject line: “PD Application for Abiotic Stress Genetics and Genomics” and send the above requested information to:

Dr. Henry Nguyen (nguyenhenry@missouri.edu)
Professor of Genetics, Division of Plant Sciences
Director, National Center for Soybean Biotechnology
1-31 Agriculture Building, University of Missouri,
Columbia, MO 65211. Tel: (573) 882-5494.

News from FESPB affiliated Journals

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plant biology

New in 2015: Plant Biology will move to online only publication, in trend with Wiley's path of digital transformation.

Call for Papers:
In 2016, Plant Biology will publish a special issue on Plants and the Changing Environment. This issue will contain a selection of the invited and contributed papers presented at the 9th Air Pollution and Global Change Symposium, Plants and the Changing Environment was held at the Asilomar Conference Center, Monterey Bay, USA, 8-12 June, 2014 jointly organized by David A. Grantz (University of California, Riverside), Kent O. Burkey (USDA/ARS, Raleigh) and Luit J. De Kok (University of Groningen). The guest editors David A. Grantz (University of California, Riverside) and Luit J. De Kok (University of Groningen) invite you to submit papers on this topic. Deadline: 31 December 2014.

Free Access to the Special Issue in 2014: Plant Biology in Space
Please hyperlink:
http://onlinelibrary.wiley.com/doi/10.1111/plb.2013.16.issue-s1/issuetoc?campaign=wlytk-41929,4211342593

Physiologia Plantarum
An International Journal for Plant Biology

Special Issues in 2014:
Auxin Biology:
http://onlinelibrary.wiley.com/doi/10.1002/ppl.2014.151.issue-1/issuetoc?campaign=wlytk-41929,
Plant Vascular Biology:
http://onlinelibrary.wiley.com/doi/10.1002/ppl.2014.151.issue-2/issuetoc?campaign=wlytk-41929,
Plant Mineral Nutrition:
http://onlinelibrary.wiley.com/doi/10.1002/ppl.2014.151.issue-3/issuetoc?campaign=wlytk-41929,