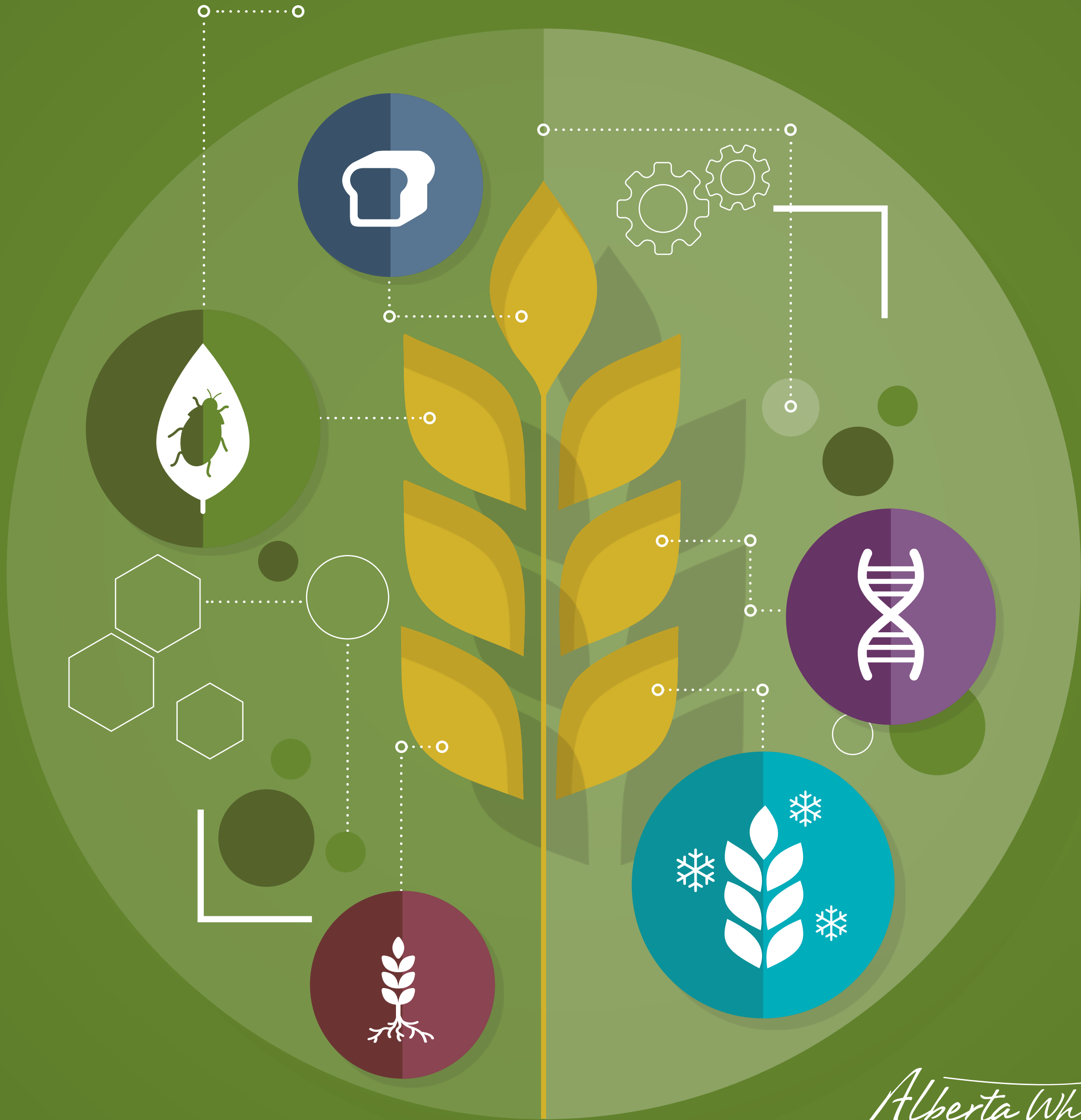
Fall 2021

Spotlight on AWC-funded Research



Alberta Wheat Commission

Interest spikes in wheat yield research

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Leaving stripe rust in the dust

DR. LAUREN COMIN
ALBERTA WHEAT AND BARLEY COMMISSIONS

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Stories written by Geoff Geddes | The Word Warrior
www.thewordwarrior.com

A message from the director of research

Research is Alberta Wheat Commission's largest investment for a reason. Development of new, improved wheat genetics and best management practices will be key to helping producers adapt to changing environments, government policies and both domestic and international market demands, all while maximizing their profit.

This edition features some of the new projects that were added to the research portfolio in 2021. Once again, researchers are finding some creative solutions to common pests. A relatively new technology, RNAi, is being applied to wireworms for a highly specific, chemical-free form of control. Scientists are also turning to wheat's relative, intermediate wheatgrass, as a source of novel stripe rust resistance. Abiotic stress is not forgotten, with a project focusing on reducing water loss and increasing water productivity as a way of improving response to drought. In a quest to improve soil health, a research project investigates the effects of crop residue management. Finally, in recognition of the importance of yield, a project targets reproductive and spike traits to ensure the bins are full at the end of harvest.

For more information on research projects and extension opportunities, visit **albertawheatbarley.com**.

DR. RAJU DALTA

Interest spikes in wheat yield research

Wheat farming and volleyball have one thing in common: they both count on spikes for success. As growers well know, large spikes with more spikelets (containing more grains) and larger grain size are one of the key factors in boosting yield. With food production needing to double by 2050 to meet global demand, wheat yield is a leading focus for science, spawning projects such as "Targeting spike traits for improving grain yield potential in Canadian spring wheat."

"We have been working on wheat crop related genetics and genomics for some time now, looking at how we can improve yields," said Dr. Raju Datla, senior scientist at the Global Institute for Food Security (GIFS) based in Saskatoon, Saskatchewan.

The spike size, spikelet number, floret number and number of grains per spike are important yield components in wheat. Yet efforts to improve these important grain yield traits in Canadian cultivars have been hampered by the limited availability of superior and well characterized genetic factors that link to the desirable spike traits. As a result, these traits are not fully explored or exploited yet in wheat breeding globally, including Canada.

MAKING GAINS WITH GRAINS

"In examining current wheat cultivars, we noted that most spikes contained 40 to 50 grains, and we felt there was room for improvement by looking more closely at the spike components," said Datla. "Upon studying the spike traits of germplasm from both Canadian and international sources, we found some wheat lines that produced 70 to 80 grains per spike, thereby enhancing yield."

While finding the lines was a good start, the next step is identifying the genes or genetic markers that are controlling the spike traits and causing certain cultivars to produce more grains in the spike. Scientists are also seeking wheat spikes with strong stocks that will support a greater number of grains, so weight is a key consideration as well.

"A lot of advances are occurring right now in crop signatures and whole genome sequencing. Our project team members are part of a large international consortium with over 100 other researchers working to better understand the genetics and genomics of wheat, so these are exciting times."

Research made possible through collaborative industry funding: SaskWheat Development Commission, Manitoba Crop Alliance

In a project of this magnitude, as in volleyball, teamwork is essential to achieving your goals.

"We are interacting with breeders locally and in Swift Current and Manitoba. As we generate information on the key genetic components and markers, we are providing breeders with the lines exhibiting the critical spike traits we desire. They will then select and prioritize the desirable genes they need to incorporate to enhance those traits."

At present, Datla and his colleagues are growing a number of lines in their greenhouse that address all four of the major yield contributors: larger spikes, and more spikelets, florets and grains. Once they identify the genes controlling these desirable spike characteristics , they will develop tools for Canadian wheat breeders to integrate those genes into their breeding programs. As a final step, the lines will be tested in a field setting where they can be impacted by a number of factors in the environment such as rain, heat and other stress conditions.

As with much of life these days, researchers are dealing with COVID-19 restrictions, which limit them to four to five hours per day working in shifts. When the world eventually returns to normal, the team hopes their study will follow suit and ramp up to full capacity.

That will be good news for growers, as the project's goals extend beyond enhancing spike traits.

INTEREST IN INPUTS

"We are trying to develop wheat lines that use water and nutrients more efficiently, thereby needing less of both. In this way, farmers can minimize inputs without sacrificing growth and productivity. For example, phosphate is not a renewable resource, so can we optimize the use of such finite elements? This is something we want to build into the program at GIFS as we go along."

Given the devastating impact of the drought this year across the Prairies, scientists on the study also aim to make wheat crops more resilient in the face of drought conditions.

"This is all about forging a more productive and sustainable wheat crop, and perhaps sequestering more carbon in the process. The lines we have developed thus far are doing well on these fronts, but there is always room for improvement."

Given the stakes, improvement is not just desirable; it's essential. As a major crop in Canada and a widely grown staple food around the globe, wheat provides 20 per cent of the calories and protein consumed by humans. It plays a pivotal role in the quest for global food security and in the effort to meet the future needs of a growing population. As Canada is the world's leading exporter of wheat and helps fill international wheat market needs, continued demand for Canadian wheat is expected. In this context, it is important that growing a wheat crop is an attractive and profitable proposition for Canadian farmers.

"In responding to the growing wheat demand, we must see a rise in yields, but that is just the beginning. We also require improved performance and productivity around environmental factors and their influence. Accordingly, the urgent need for new efforts in the genetic improvement of wheat crops has been highlighted in several publications and reports. This challenge will require development of high-yielding wheat cultivars employing advanced breeding, genetic, molecular and genomic tools and technologies."

Between the challenges of genetic complexity and the pressure for progress, researchers on this project have their work cut out for them. From Datla's perspective, however, it is less about obstacles and more about opportunity.

"I am proud to know that Canada is a major producer of high-quality wheat, and it is clear that global wheat output must double by 2050 without using additional land. As the entire industry looks to boost the numbers, Canada is sitting on a huge opportunity if we can increase production while maintaining our reputation for excellent quality, and this project fits perfectly with that mission."

DR. RAJU DALTA

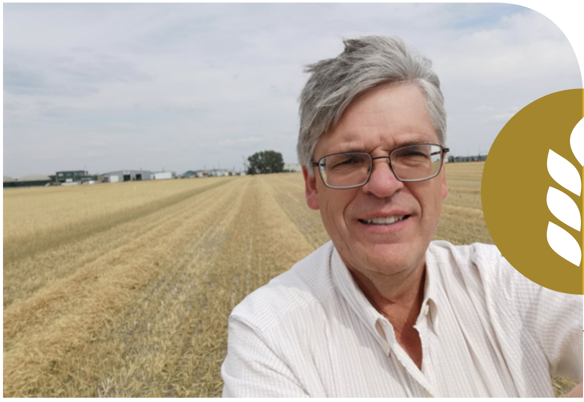
Dr. Datla joined the Global Institute for Food Security (GIFS) as a senior scientist in December of 2019. Prior to joining GIFS, he was a research staff member at the National Research Council of Canada (NRC), working as a research officer since 1993. Datla received a master's degree in plant embryology and genetics and a Ph.D. in plant genetics and evolution.

He conducted research in several strategic areas of plant biology using the model system Arabidopsis and crop species canola, flax and wheat. This research was aimed at the development of genetic tools and technologies for basic and applied plant biology studies , as well as discovery and functions of regulatory factors controlling meristems, architecture, embryo and seed development. These research contributions established his strong expertise and led to peer recognition in seed and plant developmental biology.

Datla has published over 130 research papers and is an inventor of 18 patents. Besides scientific contributions, he served in various leadership roles – as group lead, pillar lead, program lead and in coordinating plant genomics projects and initiatives.

Did you know?

- *Unlike other cereal crops like barley, maize, rice, and sorghum, each wheat spikelet bears more than one grain, making the wheat spikelet the most essential grain yield component.*
- *Wheat yield increases in the past were mainly based on a linear increase in the number of grains per square meter, while spikelet number, grain weight and biomass were largely unchanged.*



DR. BENJAMIN ELLERT

"Our priority is the management and stewardship of natural resources, and this project is right in line with that."

Soil health means **greater wealth**

Though soil doesn't sneeze or cough, farmers know when it's sick, and poor soil health can be deadly to the bottom line. Soil is literally the foundation of success for wheat crops, which explains the growing interest in research efforts on this front. As the issue of crop residue and its relation to soil gains more attention from growers, science is responding with the project "Managing crop residue carbon for soil health in wheat-based cropping systems".

The study came about as an opportunity to perform more in-depth investigations of organic matter recycling in a long-term project with different levels of harvested residue. Crop residue is the non-grain part of the plant that is often left in the field after a crop is harvested.

FEEDING A NEED

"In the early days of agriculture in Western Canada when we had large numbers of livestock on farms, the residue was removed to make animal feed and bedding," said Dr. Benjamin Ellert. Ellert is a research scientist in biogeochemistry with the Agriculture and Agri-Food Canada (AAFC) Research and Development Centre at Lethbridge, Alberta.

Residues actually have three components, each with its own potential use. The chaff (non-grain portion of the wheat head that surrounds the seed) is richer in nutrients, especially crude protein, and has the most value for livestock feed. The straw and leaves, though lower in protein and less digestible than the chaff, may contribute roughage to cattle rations. The high levels of structural carbohydrates and lignin in the straw makes it useful as livestock bedding and for a range of other non-agricultural applications. Lastly, the anchored stubble below cutter-bar height is crucial to protect the soil against erosion.

"We were pleased when the funding partners agreed to fund us, as this project is a longer-term effort than most studies and focuses on more than economics. In my role with the federal government, I take a broader look at agroecological performance, which is the application of ecological principles to agricultural systems and practices. Our priority is the management and stewardship of natural resources, and this project is right in line with that."

CENTRE OF ACTIVITIES

When it comes to taking a long-term approach, the Lethbridge Research and Development Centre is the perfect setting. It is one of the few places in the world conducting cropping system studies that date back to 1910, when "the sod busters and scientists arrived at the same time". The current study is relatively new at 20 years of age, yet long enough to accommodate ambitious goals.

"One of our main objectives is to understand how changes in harvest intensity affect the soil. Typically in the Dark Brown soil zone, the grain is the only part of the crop that is harvested. Harvest index refers to the fraction of above ground plant material that is harvested and sold off the farm or recycled, depending on the cropping system."

For this study, scientists are manipulating the residue inputs to the soil in a continuous wheat system. In one treatment, they are returning the residue to the field and only harvesting the grain, as is normally done.

In a second treatment, all the residue above cutter-bar height is removed and harvested along with the plant. This is akin to a system where harvest intensity has been increased and greater demands are being placed

Research made possible through collaborative industry funding: Sask Wheat DEVELOPMENT COMMISSION

on the land. The residue might be used for livestock, manufacturing building materials, or even as fuel (e.g. direct combustion for heating or conversion of cellulose to liquid or gaseous biofuels).

Finally, a third treatment supplements residue inputs with those from the removed treatment, effectively doubling the normal residue return. Often this prompts more practically-minded agronomists to pose a thoughtful question: what the heck are you doing?

"It's a valid question and we get a fair bit of flak for that third treatment. I am looking at nutrient cycling in agricultural systems, especially carbon and nitrogen. I would argue that farmers, whether they work with crops, livestock or both, are in the business of managing carbon, and that is the real impetus for this project."

As residues are composed primarily of carbon, the three treatments allow scientists to monitor the response of soil to various levels of carbon input.

Though the project is entering its third decade, the new funding gives researchers more avenues to explore.

MONEY MATTERS

"The additional money came during a disastrous crop year, which really underlines the need for long-term studies. We can now do detailed soil sampling to measure residue carbon retention and decomposition, and are especially interested in how the soil responds if we push the system harder and harvest as much residue as possible."

Those who oppose harvesting crop residues point to their importance in soil conservation, something Ellert readily acknowledges. He views this work as a chance to quantify the implications of residue harvesting. How much will this decrease soil carbon stocks? How much will accumulate if residue inputs are doubled?

"Crop residues are very important for retaining soil against the forces of erosion, especially wind erosion in dry years and water erosion in wet years. Additionally, just as you dump your coffee grounds and banana peels in the garden for compost, residues are a good source of nutrients that we can recycle. Given their value, we need to fully grasp the implications of harvesting them."

When researchers look at soil health, they want to gauge the extent to which they can safely increase harvest intensity under zero-till in Dark Brown soils where residue production is marginal. Is it acceptable from a soil health perspective to harvest that residue from non-irrigated systems?

"The question takes on added complexity in modern farming where mostly low or zero tillage systems are employed. When you don't have tillage mixing those residues into the soil, there is less risk of erosion."

Though the team was thwarted in its efforts to conduct detailed sampling of the soil carbon stocks this spring, it remains eager to move forward with that in the fall. Instead, Ellert explained that "we collected samples shortly after seeding to distinguish the surface residue mat from those intermingled with the mineral topsoil, and we are working through the analysis as we speak."

For growers, this means that help for sick soil is on the way. If you hear your soil sneezing or coughing, however, you're on your own.

DR. BENJAMIN ELLERT

Dr. Ellert is a research scientist in biogeochemistry with the Agriculture and Agri-Food Canada Research and Development Centre at Lethbridge. He earned a Ph.D. in soil science, and has considerable experience in research on the cycling of carbon, nitrogen and other chemical elements that are transformed and transferred between living organisms and the environment in agroecosystems.

He studies the land-atmosphere exchanges of greenhouse gases associated with biogeochemical cycling, applies isotopic techniques to trace element flows in the environment, and gleans insights from assorted long-term field experiments. Ellert's interest in agriculture stems from his early years on a small mixed farm at Milk River in southern Alberta.

Did you know?

- *Soil is by far the most biologically diverse material on Earth.*
- *Soil contains a large variety of organisms which interact and contribute to many global element cycles, including the carbon and nitrogen cycles.*
- *Soil provides vital habitats for micro-organisms such as bacteria and fungi, as well as insects and other animals upon which plants and all life depend.*

DR. JOHN LAURIE

DR. HAYLEY CATTON

Teaming up to bring down **wireworms**

While some activities like solitaire and unicycling are best done alone, others need a team approach. That is clearly the case with fighting wireworms, the highly destructive insect pests of grain crops in Western Canada that feed below ground on seeds and shoots. Wireworms in all growth stages are likely to infest a field in long-term grass or pasture, with populations in the soil often numbering more than three million per hectare. In Alberta, damage to wheat crops ranges from one to 50 per cent annually, which prompted two researchers to team up on the project "Investigating RNAi as a management tool for prairie wireworms".

"My expertise is in RNAi, and Dr. Catton is an expert in insect ecology, so it made for the perfect fit," said Dr. John Laurie, research scientist, Enabling Technologies with Agriculture and Agri-Food Canada (AAFC) at the Lethbridge Research and Development Centre.

The term RNA interference (RNAi) was coined to describe a cellular mechanism that uses the gene's own DNA sequence to turn it off, a process that researchers call silencing. In a wide variety of organisms, including animals, plants, and fungi, RNAi is triggered by double-stranded RNA. RNAi is widely used by researchers to silence genes in order to learn something about their function.

BY POPULAR DEMAND

"The funders encouraged Dr. Laurie and I to collaborate on this challenging insect; our skill sets are a good match," said Dr. Haley Catton, research scientist, Cereal Crop Entomology with AAFC.

In the scientific battle with pests, finding alternative management techniques for wireworms other than pesticides has been identified as a priority.

"Pesticides sometimes disappear off the market, so we are always looking for non-chemical alternatives to reduce insect problems," said Catton. "The emerging method for that is using RNAi, and this project is about developing an RNAi process for use with wireworms."

For cereal growers on the Prairies, wireworms are the main impetus for insecticide seed treatments, so an RNAi option would mean fewer chemicals, less expense, and a more precise, surgical approach to pest control that chemicals simply cannot match. Whereas pesticides often attack more than just the intended target, killing off things like beneficial organisms that help plant growth, RNAi is more specific, akin to looking up a certain word in the dictionary.

DON'T SAY IT SPRAY IT

"A lot of work has been done in creating RNAi sprays for insects," said Laurie. "In the past, these sprays were unfeasible due to their cost of production, but they have gotten cheaper and cheaper in recent years."

Drawing on Laurie's previous work employing RNAi for seed coat technology, this study is unique in that it uses seed coating rather than spraying a field with RNAi. As a result, growers can use less and treat only what they want to protect, that being the young seeds and developing seedlings.

"This project is proof of concept that such an approach will be effective," said Laurie. "Initially, it should protect the seedling for the first week or two, and we hope to have a slow release system down the road that safeguards seeds in the long term."

Speaking of long-term, another advantage to RNAi technology is its short lifespan, so it doesn't hang around to pollute the environment as happens with pesticide residue.

Before those breakthroughs can emerge, a lot of leg and eye work must occur.

Research made possible through collaborative industry funding: SaskWheat DEVELOPMENT COMMISSION WGRF Advancing Agriculture through Research

"We need specimens to do the experiments and look for genes that are specific enough to the insects we want to target," said Catton. "Step one is to get field samples in the lab where Dr. Laurie can determine which genes are being expressed. We did the collections this summer and froze them so he can catalogue the genes and gives us options for what to target."

TOOLS THAT TARGET

While the knowledge gained through science often has an impact on growers, this study aims to go a step farther and arm them with the tools for success.

"As scientists, we are always trying to give farmers the information they need to make the best possible decisions for their operation, both economically and environmentally," said Catton. "But what if we could offer them a tool that has advantages over their current strategy of pesticide use and help them use this technology with confidence? The result would be a more targeted approach, cost savings and a reduction in non-target effects like the loss of beneficial insects."

For both researchers, the chance to be on the cutting edge of technology and help shape the future of farming makes the work worthwhile.

"I see RNAi as a big part of insect control going forward," said Catton. "It is already being used with corn pests in the United States and is a huge leap from broad spectrum pesticides. In a perfect world, we would move into agricultural systems, remove the pest insects and leave the good insects to do their thing. RNAi has the potential to minimize disruption to the insect community and support the sustainability and resilience of wheat production for years to come."

DR. JOHN LAURIE

Dr. John Laurie is a research scientist - Enabling Technologies with Agriculture and Agri-Food Canada (AAFC) at the Lethbridge Research and Development Centre. Prior to joining AAFC, the Edmontonian did his postdoctoral research in the United States (Arizona and Nebraska) and at the University of Cambridge in England.

Laurie holds a Ph.D. in Botany from the University of British Columbia and is an expert in plant and fungal genomics. His current research efforts are focused on improving cereals using biotechnology, but in a broader sense, Laurie is interested in genome evolution and the natural processes driving genetic variation in nature.

DR. HAYLEY CATTON

Dr. Haley Catton is a research scientist - Cereal Crop Entomology with AAFC. She hails from the Prairies and spent her formative years just north of Winnipeg. Her extensive education includes a Ph.D. from the University of British Columbia - Okanagan (Plant-Insect Interactions), and a M.Sc. (Plant Science) and B.Sc. (Agriculture – Plant Systems) with Distinction from the University of Manitoba.

At present, Catton studies the impact and biology of pest and beneficial insects in cereal crops. Her expertise includes plant-insect interactions, population biology, biological control and integrated pest management. Her current projects focus on wireworm, cereal leaf beetle, and wheat stem sawfly and their natural enemies (beneficials).

Did you know?

- *The pest wireworms we have on the Prairies are different species than in other regions of Canada. There are four main pest species on the Canadian Prairies and all are native to this region.*
- *The adult wireworm is known as the click beetle, because of its habit of clicking or snapping its body into the air when placed on its back. It varies in color from tan to black and ranges in length from one-quarter inch to over one inch, with the most common pest species averaging about one-half inch.*
- *AAFC is coming out with a field guide for wireworms this fall. The guide was co-funded by the Alberta Wheat Commission and the Western Grains Research Foundation. Free digital and print hard copies will be available in English and in French.*

Part of my intent in this study is to quantify the diversity within the Canadian National Wheat Improvement Program regarding night-time water loss."

DR. RAJU SOOLANAYAKANAHALLY

Recipe for wheat success? **Just add water**

Water retention may be a hassle for humans, but it's vital for wheat. That fact was painfully obvious in the prairie drought of 2021, and it could be the new normal as global warming continues to wreak havoc on global crops. Responding to this challenge is a growing area of interest for science and industry, and was the impetus for the project "Adapting wheat to arid environments: mining Canadian germplasm for reduced night-time water loss and improved water productivity."

"Between 1964 and 2007, seasonal drought episodes and heat waves resulted in approximately three billion metric tons of crop yield losses around the world," said Dr. Raju Soolanayakanahally, research scientist with Agriculture and Agri-Food Canada (AAFC) at the Saskatoon Research and Development Centre.

TURNING UP THE HEAT

Wheat yield models indicate that a one degrees celcius rise in atmospheric temperature reduces wheat yield by 10 per cent, and leading wheat belts in North America could experience warmer summers by 2050. In 2017, Canadian spring wheat yields declined by 9.2 per cent from 52.0 bushels per acre in 2016 to 47.2 bushels per acre. This decline was due to the very dry conditions in the Prairies where precipitation during the growing season was significantly lower than average.

"Going forward, breeding stress resilient crops is an international issue of strategic importance. Through this project, in collaboration with AAFC's Canada Western Red Spring (CWRS) breeders, we want to assess the adaptability of wheat germplasm for arid environments for the long-term sustainability of agriculture. We chose to focus on CWRS as it is a widely grown wheat class in Western Canada, accounting for 60 per cent of annual production. It has high protein content that is well regarded for its superior milling and baking quality."

DARK THOUGHTS

When it comes to the leading plant stressors, lack of water is high on the list. As with humans, bad things can happen to wheat when night falls, so water loss after dark is a central theme of this study.

"Night-time water loss is a physiological process that accounts for up to 30 per cent of the crop's daily water use. With climate change, the frequency of high evaporative night-time environments is expected to rise and induce higher levels of transpiration (the process of water movement from soil through a plant and its evaporation) from crops."

For the most part, industry knowledge is sparse regarding night-time water loss for major crops grown in arid environments of Western Canada. Fortunately, where an information gap exists, science is there to fill the void.

"As our days get warmer, we can't reduce daytime water loss, but losing water at night is wasteful as the plant is not producing any biomass in that period. Part of my intent in this study is to quantify the diversity within the Canadian National Wheat Improvement Program regarding night-time water loss. We can then group wheat lines into those that are reckless spenders of water and those that are thriftier with their supply."

In a good year with ideal conditions, that "reckless spending" might not be an issue, but 2021 reminded growers that severe heat and drought is a constant threat. Such conditions can lead to serious soil moisture deficits, and the plants that survive are those that "spend" their water strategically.

"If a plant is thrifty, it adapts to dry conditions by closing its stoma completely at night and sealing in all the water."

Research made possible through collaborative industry funding: Sask Wheat Development Commission, Manitoba Crop Alliance, WGRF Advancing Agriculture through Research

Stomata (the singular is "stoma") are tiny openings or pores found in the epidermis of leaves and young stems that aid in gas exchange, essentially allowing the plant to breathe. They also help protect a plant from dehydration caused by excessive loss of water.

"In a year like this, that thrifty plant would ration itself and save an additional five to ten days of water. At night, instead of seasonal water loss of 50 milliliters, it might only lose 25 milliliters, conserving fluids and protecting itself from severe dehydration."

AS THE WORLD TURNS

With climate change, the judicious use of water by wheat becomes even more important.

"When we have periods like we did this season where the forecast only calls for rain 10 days from now, the thrifty spenders will hold on until the moisture comes, so it is really about security against time."

While farmers currently measure success by looking at bushels per acre or kilograms per acre, and breeders track maximum yield per acre, growers might be well advised to incorporate water use in their number crunching.

"I call it 'water productivity', as it looks at the yield you achieve per millimeter of water. Farmers prepare budgets for things like seed, pesticide and insecticide; however, unless they are using an irrigation system where they pay for water, they don't scrutinize it the same way in rain fed conditions."

Though the project is in its first year, there are similar studies being conducted around the globe, which could well be a sign of the times.

"Many countries are looking at this as Mediterranean and temperate climates get warmer. They are exploring ways to save water, and reducing night-time water loss is one of the most effective methods of doing that."

Closer to home, once the water conservation trait becomes integral to breeding programs, Soolanayakanahally sees this project as supporting a key research and development target of the prairie wheat commissions by enhancing water-use efficiency and grain productivity.

"SaskWheat wants to reduce environmental impact to enhance wheat producers' profitability, and the Alberta Wheat Commission has targeted improving grain yield under normal and abiotic stress conditions. The Manitoba Crop Alliance is seeking to build and sustain high functioning collaborative working relationships with other organizations that share common objectives. All three prairie wheat producer groups recognize the importance of stress resilient wheat to keep Canada competitive on the global wheat stage and supply quality wheat to local markets."

Although the study's work is being performed in the Prairie region, project findings will eventually have national applications. In the meantime, identifying better suited wheat cultivars for prairie climates should lead to greater profits for western Canadian farmers, and in the end, that's what ag research is all about.

DR. RAJU SOOLANAYAKANAHALLY

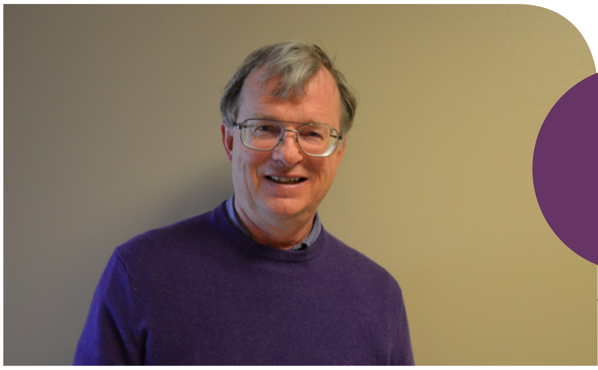
After receiving a B.Sc. (Agriculture) and M.Sc. (Crop Physiology) from the University of Agricultural Sciences in Bengaluru, India, Dr. Soolanayakanahally went on to obtain a Ph.D. in Forest Sciences from the University of British Columbia. Since 2010, he has been a research scientist at Agriculture and Agri-Food Canada.

His research focuses on the development and evaluation of new poplar and willow feedstocks for bioenergy opportunities, carbon sequestration and environmental services. Recent efforts include the combination of bioenergy and biochar applications to soil, which offer the opportunity to develop a carbon-negative energy technology which, at the same time, improves the environment.

At Saskatoon, his lab works on understanding the growth, developmental, physiological, and metabolic responses of plants and their interaction with the environment in which they grow, their mechanisms of tolerance to various environmental stresses, and their acclimation and adaptation mechanisms. The lab mainly focuses on photosynthesis and resource-use efficiency, especially in the area of water and nitrogen

Did you know?

- *Future research programs aimed at improving crop tolerance to naturally occurring environmental conditions should focus on developing crops that can withstand a variety of stress combinations, including drought, heat and salinity.*
- *In arid environments, night-time transpiration may contribute to eight to 55 per cent of daytime transpiration.*



DR. ANDRE LAROCHE

Even with modern methods, however, patience is a key asset in this endeavor.

Leaving stripe rust **in the dust**

If a stuffy nose from a cold drags you down, imagine being yellow and plagued with pustules. That is often the fate for wheat infected with stripe rust, a fungal disease for which limited resistance exists. Today, stripe rust represents a significant annual threat to wheat growers. In response, science is ramping up its attack on stripe rust with studies such as "Introgressing Thinopryum intermedium stripe rust resistance genes into wheat".

"The main driver of this study is the reality that there are a limited number of effective genes available for stripe rust resistance, so what can we do to fill the gap?" said Dr. André Laroche, research scientist with Agriculture and Agri-Food Canada (AAFC) at the Lethbridge Research and Development Centre.

"There is a constant battle between plants and pathogens. While the pathogen's goal is to infect and invade the plant and multiply, the plant tries to defend itself and produce the maximum number of seeds."

AN UNFAIR FIGHT

To make matters worse, pathogens are able to create mutations in their genome so they can infect plants more efficiently. Thus, science searches for disease resistant genes that they can bring together and bolster the plant's defenses, but a problem arises when those genes are hard to find.

"In that instance, we need to look elsewhere, such as obscure wheat lines or wild species that appear to be resistant against a number of pathogens. Some of the genes discovered this way are still useful today, but they largely relate to diseases like leaf rust, stem rust and powdery mildew."

Until recently, researchers paid little attention to stripe rust as it was confined to relatively small areas. For example, it favoured cool weather and high humidity common in irrigated regions of southern Alberta and the Pacific Northwest in the United States. That all changed in 2000 when a new race of stripe rust was found to be infecting wheat in places it never did before, and performing better in warmer temperatures and drought conditions.

"Over the years, we found that if you tried to battle stripe rust with a single resistant gene, the gene would be defeated rapidly. Because the pathogen has a superior ability to mutate compared to leaf rust or stem rust, you need a number of resistant genes working together to keep it in check."

That discovery raised the challenge of finding multiple genes that were up to the task. In collaboration with a colleague, Dr. Jamie Larson, who was working on wheat grass, Laroche encountered 225 lines, with only one or two infected by stripe rust. This served as the starting point in his quest to identify new resistant genes, leading to the current study and efforts to identify potential resistant genes based on their DNA sequence. Scientists can then "tag" these genes, follow them and make crosses to accelerate the breeding process.

WORTH THE WAIT

Even with modern methods, however, patience is a key asset in this endeavor.

"Since we are starting with a wild species, it takes time to move the resistant genes from one of those lines to elite germplasm and breed wheat lines that will exhibit stripe rust resistance and produce bumper crops in the process."

If all goes as planned, that patience should be well rewarded. There are only a finite number of stripe rust resistant genes available at present, and as the ever-evolving stripe resistant pathogen defeats them over time, those genes will eventually be rendered ineffective.

Research made possible through collaborative industry funding: SaskWheat Development Commission

PAYING THE PRICE

"What do you do when you no longer have resistant genes to put in your wheat cultivars? There are fungicides available, but if you look at the situation in Europe, there are a number of fungicides that are now ineffective against stripe rust. This may be less true in North America right now as stripe rust has only been prevalent since 2000. As we continue to use fungicides, however, isolates from the pathogen will develop a resistance to them."

As well, the number of fungicides available is limited, and it is becoming more difficult to develop new ones, as there is both a financial and environmental cost associated with using them.

"In ten years, we still want the option to grow wheat in a profitable manner, and the most effective way of protecting a plant is always the use of genetic resistance, as it is something that comes with the plant and does not require external inputs. For farmers down the road, we want to ensure they have access to a new series of stripe rust resistant genes that could be deployed in future years and remain effective in protecting wheat crops."

To that end, the resistant genetic wheat lines obtained at the end of the project will be made available to all the public wheat breeders of Canada. Researchers will also provide direction on the crosses to be made to ensure that resistant genes will be present in the most adapted and useful germplasm.

PRIMING THE PIPE

"The important step here is the deployment of a selection of different and effective resistant genes into high quality wheat lines that can be used in the pipelines of the different Canadian wheat breeding programs. We have an integrated research team that includes wheat breeders that will make the transfer and adoption of the new technology seamless."

This team will develop unique know-how on identifying and characterizing disease resistant genes and efficiently incorporating them into elite wheat germplasm.

"Projects like this that take longer to show results are critical for the industry. I don't think we will see the genes we are isolating for another 10 to 12 years in the field, so for the sake of growers and breeders, we need to start now."

DR. ANDRE LAROCHE

Dr. Laroche is a research scientist with Agriculture and Agri-Food Canada at the Lethbridge Research and Development Centre. He has more than 35 years of research experience in the areas of plant molecular biology and molecular phytopathology. His research interest widely ranges from cereal functional genomics of biotic (stripe rust, snow mold, smut and bunt,) and abiotic stress tolerance (drought, and heat tolerance, winter hardiness), to methodology development, DNA marker assisted selection, and gene modification.

His current scientific interests involve the characterization of stripe rust pathogen isolates and their interactions with wheat and identification of novel rust resistance genes. He also edits genes with a collaborator to improve their response against pathogens and to variable climatic conditions. He is affiliated as an Adjunct Professor with the Department of Biological Sciences, University of Lethbridge.

Did you know?

- *In Canada we have a plant gene bank known as the Plant Gene Resources of Canada. Located in Saskatoon, it houses a collection of thousands of cereal and other crop seeds.*
- *DNA is the genetic material of most living organisms from virus to bacteria to fungi to plants and mammals, including humans. In all these organisms, the chemical composition of the DNA is the same. Consequently, the same tools to decipher DNA can be used.*
- *The genome is the genetic material of an organism, and its size is based on the number of units (bases) that it contains. The human genome is evaluated at 3.3 billion bases (Gbases). The wheat genome is five times larger than the human genome at 17.0 Gbases.*

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