Researchers launch new 'Rust-Tracker' to monitor deadly wheat fungus in 27 nations

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The world's top wheat experts today reported a breakthrough in their ability to track Ug99 and related strains of a deadly and rapidly mutating wheat pathogen called stem rust that threatens wheat fields from East Africa to South Asia. With data submitted by farmers and scientists from fields and laboratories, the creators of the "Rust-Tracker" say they now can monitor an unprecedented 42 million hectares of wheat in 27 developing countries in the path of a windborne disease so virulent it could quickly turn a healthy field of wheat into a black mass of twisted stems and dried-up grains.

"Wheat rusts are global travellers with no respect for political boundaries, and it is highly likely that some of the virulent new strains related to Ug99 will eventually be carried across the Middle East and Central Asia and into the breadbaskets of Pakistan, China and India," said Dave Hodson, developer of Rust-Tracker and a scientist with the International Maize and Wheat Improvement Center (CIMMYT). "Effective control often depends on finding out what is happening in distant regions, and the Rust-Tracker can help scientists assess the status of stem rust and other rust diseases, not only in their own countries, but also in neighboring countries."

At the start of a four-day symposium organized in Beijing by the Borlaug Global Rust Initiative (BGRI), 1-4 September, scientists reported significant progress with developing and introducing 20 new varieties of rust-resistant wheat over the last few years. Seed for the new varieties is being deployed and multiplied in eight frontline nations to

produce enough seed for farmers to plant to prevent massive crop loss in case of an epidemic. But the experts in Beijing warned that wheat fields in a significant number of countries remain largely unprotected from the dangerous pathogen.

"The research being presented at this meeting takes us significantly closer to our goal of protecting the global wheat crop from rust diseases," said Ronnie Coffman, principal investigator and director of the Durable Rust Resistance in Wheat Project and vice chair of BGRI. "But the vast wheat-growing region that stretches across North Africa and Central Asia all the way to the gateway to China—the world's largest wheat-growing nation—is still vulnerable."

Other studies presented in Beijing report on progress with isolating genes that confer resistance to Ug99 in a wild relative of wheat from Israel and Lebanon, as well as new insights regarding barberry, a woody plant that was once eradicated in Europe and North America because it serves as a host for stem rust, allowing the rust to survive and propagate between wheat-growing seasons. Researchers, who find barberry growing in regions of the world known to be hotspots for new strains of stem and yellow rust, are now investigating a possible link between the plant and the increased virulence of emerging rust diseases.

Tracking the rusts

An estimated 85 percent of wheat now in production, including most wheat grown in the Americas, Asia and Africa, is susceptible to Ug99 and its variants. For now, however, only the original mutation, Ug99, has been found outside of Africa—in Yemen and Iran. Stem rust can cause farmers to lose their entire crop, but a second rust disease is already causing severe losses worldwide. Like stem rust, yellow rust (also known as stripe rust) has in recent years become more of an immediate threat, with the emergence of new, highly-aggressive strains that are able to

knock out genetic resistance in many of the most popular varieties of wheat. Among the countries that have suffered devastating yellow rust epidemics are Azerbaijan, Ethiopia, Iraq, Morocco, Syria, Tajikistan and Uzbekistan, with yield losses as high as 40 percent.

"We need urgent concerted action to address yellow rust," said Mahmoud Solh, director general of the International Center for Agricultural Research in the Dry Areas (ICARDA). "It is a significant problem from the Middle East all the way to China. In any new varieties of wheat we develop, we need to build in durable resistance to both stem rust and yellow rust."

Using Rust-Tracker data, Hodson and his colleagues in Beijing are developing "risk maps" that can assist researchers in countries in the path of virulent strains of stem rust and yellow rust to assess the severity of the threat and prepare to resist it.

Taking the new wheat to the farmers

"The only manageable solution for farmers who cannot afford fungicides when rust hits is to replace their crop with new rust-resistant varieties," Coffman said. "And this is a challenge when the wheat looks healthy."

"Planting only five percent of a nation's wheat fields with seed from resistant varieties would allow replacement of susceptible varieties within a year, if Ug99 should appear," Coffman said.

Leading the efforts to accomplish that aim are Afghanistan, Bangladesh, Ethiopia, Egypt, India, Kenya, Nepal and Pakistan, which are choosing from among the more than 20 rust-resistant varieties developed by ICARDA and CIMMYT. All eight nations are expected to pass the 5 percent mark in the 2012-13 growing season. The new varieties are not only resistant to stem rust but to other rusts as well, Coffman said.

"It's frustrating," Coffman said. "We have the technology to prevent a tragedy that could destroy crops in one of the world's most important wheat-producing regions, an area that is already vulnerable to hunger and civil unrest. But the funding is not in place to get enough rust-resistant wheat seed multiplied fast enough and into the hands of the people who need it."

Seeking solutions in wild relatives of wheat

As part of a global effort to stay ahead of the rapidly mutating pathogen, a group of researchers from the Sainsbury Laboratory in Norwich, the University of Minnesota and the University of Tel Aviv will report in Beijing on their search for genes that confer resistance to Ug99 in a wispy grass that grows on the coastal plains of Israel and Lebanon. Under increasing pressure from development in the region, this wild relative of wheat, or Sharon Goatgrass (Aegilops sharonensis), may hold the key to protecting the world's most important food crop from Ug99 and its variants.

"Within four or five years we hope to be able to isolate these genes, take them out with our molecular tweezers and put them into locally-adapted high-yielding bread wheat," said Dr. Brande Wulff, a researcher with the Sainsbury Laboratory who will report on his work at the workshop in Beijing. "We hope to create a formidable obstacle to the pathogen."

Barberry may harbor key to virulence in hot spot nations

Concern about the growing virulence of both stem rust and yellow rust has led to renewed interest in a woody plant known as barberry, common to wheat-growing regions, which hosts both yellow rust and stem rust. Recent studies suggest that systematic eradication of common barberry

plants in the mid-20th century reduced not only the severity of rust epidemics, but also the evolution of the pathogen. "This is what contributed to decades of durability of the genes protecting wheat varieties used worldwide against stem rust," said Iago Hale, a plant biologist with the University of New Hampshire in the United States. "And then came Ug99."

Scientists from the US, China, Sweden, Ethiopia, Russia, Kenya and other countries will report findings that indicate a possible role for the woody plant in boosting the virulence of rust diseases, though the link in eastern Africa remains to be proven.

"Almost wherever we have looked for barberry, we have found it, and it almost always has been near wheat," said Hale, who is moderating a session at the Beijing symposium devoted to the plant. "Initial findings suggest we should have been looking for barberry throughout the world's wheat-growing regions."

For now, Hale added, the modern-day "barberry hunters" in eastern Africa have faced technical difficulties in proving that stem rust variants are developing on natural populations of barberry plants. The relatively fragile spores of rust lose viability during transit to laboratories in Europe or North America. But he says scientists are committed to researching a link between barberry and the rapidly evolving variants of stem rust from Africa that threaten the global wheat supply.

Unlike what has been done in the past in Europe and North America, eradicating barberry may not be an option, he said. "In some countries, the plant is used for medicinal purposes, or it has cultural importance, so we'll have to proceed carefully."

"Rust never sleeps"

The BGRI was launched in 2005 by Dr. Norman Borlaug, who often said that "rust never sleeps." He was right. After confirming that Ug99 had overcome the resistance gene he and others had developed for wheat more than 50 years before, Borlaug began his campaign to make the world pay attention to the new threat to global food security.

Borlaug received a Nobel Peace Prize in 1970 for fighting stem rust, while developing and introducing new varieties of wheat that saved some of the world's poorest people from famine. In the last four years of his life, he took up the battle anew against his ancient enemy, urging significant investments in agricultural research and leaving behind an army of scientists with the means to continue the work.

Scientists from every region of the world are attending the meeting in Beijing, which was organized by the Durable Rust Resistance in Wheat (DRRW) project for the Borlaug Global Rust Initiative (BGRI). Funded by the Bill & Melinda Gates Foundation and the UK Department for International Development (DFID), the DRRW is managed by Cornell University. Partners include CIMMYT, the Syria-based International Center for Agricultural Research in the Dry Areas (ICARDA), the Food and Agriculture Organization of the United Nations (FAO), and the Indian Council of Agricultural Research (ICAR), among others. Both CIMMYT and ICARDA are members of the CGIAR Consortium. For more information, see http://globalrust.org/

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