Resistance gene found against Ug99 wheat stem rust pathogen

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The world's food supply got a little more plentiful thanks to a scientific breakthrough. Eduard Akhunov, associate professor of plant pathology at Kansas State University, and his colleague, Jorge Dubcovsky from the University of California-Davis, led a research project that identified a gene that gives wheat plants resistance to one of the most deadly races of the wheat stem rust pathogen—called Ug99—that was first discovered in Uganda in 1999.

The discovery may help scientists develop new wheat varieties and strategies that protect the world's food crops against the wheat stem rust pathogen that is spreading from Africa to the breadbaskets of Asia and can cause significant crop losses.

Other Kansas State University researchers include Harold Trick, professor of plant pathology; Andres Salcedo, doctoral candidate in genetics from Mexico; and Cyrille Saintenac, a postdoctoral research associate currently working at the Institut National de la Recherche Agronomique in France. The project was funded by the U.S. Department of Agriculture and Borlaug Global Rust Initiative.

The team's study, "Identification of Wheat Gene Sr35 that Confers Resistance to Ug99 Stem Rust Race Group," appears in the journal *Science*.

It identifies the stem rust resistance gene named Sr35, and appears alongside a study from an Australian group that identifies another

effective resistance gene called Sr33.

"This gene, Sr35, functions as a key component of plants' immune system," Akhunov said. "It recognizes the invading pathogen and triggers a response in the plant to fight the disease."

Wheat stem rust is caused by a fungal pathogen. According to Akhunov, since the 1950s wheat breeders have been able to develop wheat varieties that are largely resistant to this pathogen. However, the emergence of strain Ug99 in Uganda in 1999 devastated crops and has spread to Kenya, Ethiopia, Sudan and Yemen, though has yet to reach the U.S.

"Until that point, wheat breeders had two or three genes that were so efficient against stem rust for decades that this disease wasn't the biggest concern," Akhunov said. "However, the discovery of the Ug99 race of pathogen showed that changes in the virulence of existing pathogen races can become a huge problem."

As a first line of defense, wheat breeders and researchers began looking for resistance genes among those that had already been discovered in the existing germplasm repositories, he said.

"The Sr35 gene was one of those genes that was discovered in einkorn wheat grown in Turkey," Akhunov said. "Until now, however, we did not know what kind of gene confers resistance to Ug99 in this wheat accession."

To identify the resistance gene Sr35, the team turned to einkorn wheat that is known to be resistant to the Ug99 fungal strain. Einkorn wheat has limited economic value and is cultivated in small areas of the Mediterranean region. It has been replaced by higher yielding pasta and bread wheat varieties.

Researchers spent nearly four years trying to identify the location of the Sr35 gene in the wheat genome, which contains nearly two times more genetic information than the human genome.

Once the researchers narrowed the list of candidate genes, they used two complimentary approaches to find the Sr35 gene. First, they chemically mutagenized the resistant accession of wheat to identify plants that become susceptible to the stem rust pathogen.

"It was a matter of knocking out each candidate gene until we found the one that made a plant susceptible," Akhunov said. "It was a tedious process and took a lot of time, but it was worth the effort."

Next, researchers isolated the candidate gene and used biotechnical approaches to develop transgenic plants that carried the Sr35 gene and showed resistance to the Ug99 race of stem rust.

Now that the resistance gene has been found, Akhunov and colleagues are looking at what proteins are transferred by the fungus into the wheat plants and recognized by the protein encoded by the Sr35 gene. This will help researchers to better understand the molecular mechanisms behind infection and develop new approaches for controlling this devastating pathogen.

Provided by Kansas State University