Wheat's ancient roots of viral resistance uncovered

March 6 2023

Credit: Wikipedia

The DNA sequence of a gene in wheat responsible for resisting a

devastating virus has been discovered, providing vital clues for managing more resistant crops and maintaining a healthy food supply.

Wheat crops across the Americas, Asia, Europe, and Africa are frequently ravaged by wheat yellow mosaic virus, so there is high demand for wheat varieties or cultivars that can resist this virus.

Published today in *Proceedings of the National Academy of Sciences*, the study found the resistance gene originated in an ancient Mediterranean wild plant relative of wheat.

Study lead researcher University of Melbourne Dr. Mohammad Pourkheirandish said, "This discovery could assist with the development of more resistant wheat cultivars, increase crop yields, and reduce the use of harmful fungicides. It also emphasizes the need to preserve biodiversity to protect food supplies."

WYMV reduces grain yield by up to 80%, causing significant economic losses. The virus is hosted and transmitted by a soil-dwelling fungus that colonizes the roots of wheat plants, discoloring wheat leaves, and stunting plant growth.

Microscopic fungal spores containing WYMV can live in soil for up to a decade. While fungicides can kill the spores and stop transmission, the fungicide treatment is neither cost-effective nor ecologically sustainable.

"The viable alternative is to selectively breed or genetically engineer wheat with resistance to WYMV," Dr. Pourkheirandish said.

"Before this research, we knew that a dominant gene called Ym2 reduces the impact of WYMV on wheat plants by more than 70%, but we didn't understand how the gene achieved this."

The research team used a technique called positional cloning to locate the Ym2 gene on a chromosome in bread wheat, and found that its DNA sequence codes for a protein of the type known as NBS-LRR. These proteins are "guardians" that detect pathogens and trigger an immune response in plants.

"Now that we know the gene's DNA sequence, we can select breeding lines carrying Ym2 by simply analyzing DNA from a small piece of leaf even without the virus inoculation step," Dr. Pourkheirandish said.

"It will also make it easier to find variants of Ym2 in wild relatives of wheat, which may provide superior disease resistance for further crop improvement."

The DNA of modern wheat is chimeric, meaning its genetic material derives from several ancestral plants through natural interbreeding, or hybridization, followed by selective breeding by humans.

By comparing DNA sequences across related species, the researchers discovered that Ym2 in modern bread wheat derives from an ancient wild plant called Aegilops sharonensis, native to eastern Mediterranean countries. A similar gene occurs in Aegilops speltoides, another wild ancestor of bread wheat.

"These wild species would have interbred with cultivated wheat at some point and passed on the genetic resistance that is now so commercially critical," Dr. Pourkheirandish said.

"Ancestral wild plants are a rich source of useful traits, like disease resistance, that plant breeders and geneticists can mine to protect modern crops and maintain a healthy food supply—including the bread, pasta, noodles, couscous, pastries, cakes and other wheat products that many of us depend upon and enjoy."

More information: Mishina, Kohei et al, Wheat Ym2 originated from Aegilops sharonensis and confers resistance to soil-borne Wheat yellow mosaic virus infection to the roots, *Proceedings of the National Academy of Sciences* (2023). DOI: 10.1073/pnas.2214968120

Provided by University of Melbourne