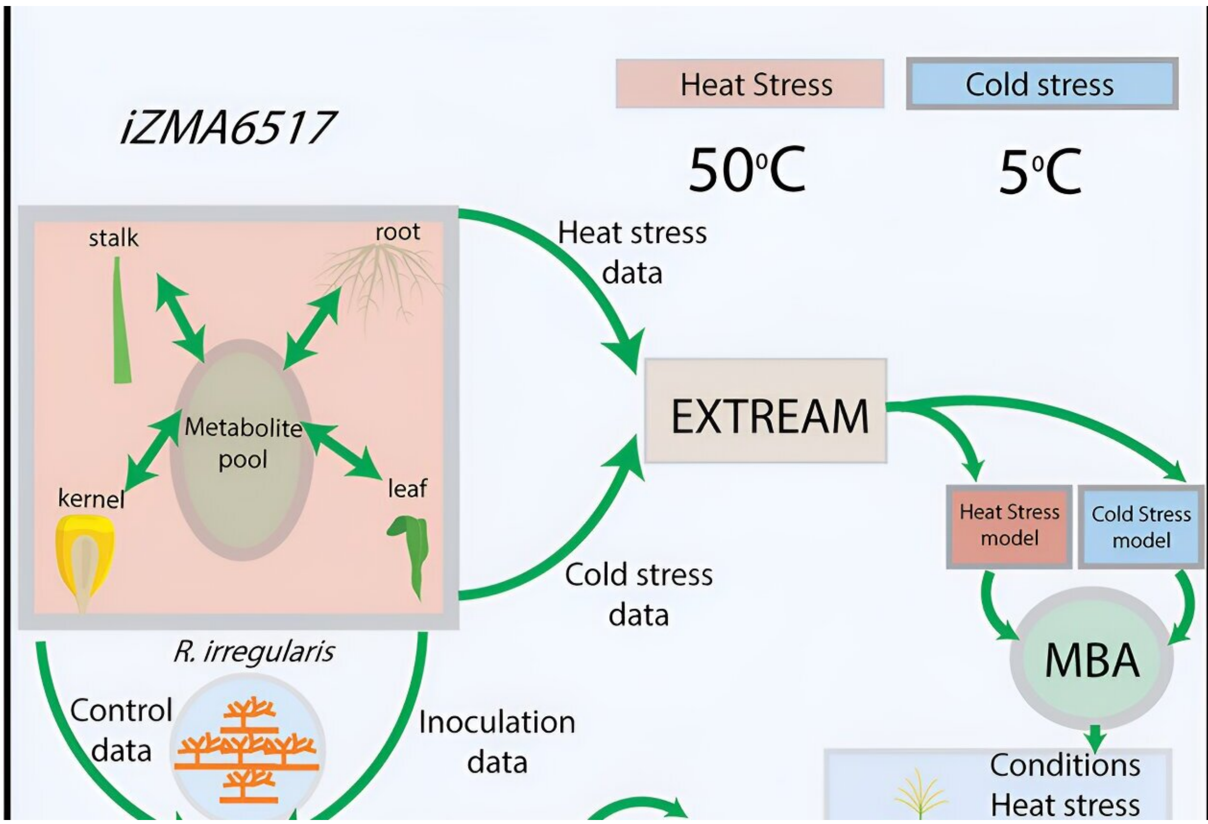
Researchers use metabolic model to study temperature stress on corn

January 30 2024, by Dan Moser



Credit: *iScience* (2023). DOI: 10.1016/j.isci.2023.108400

A research team led by Nebraska scientists has built the largest-ever metabolic model of corn to study how temperature stress affects the plant and how a certain fungus can help alleviate the problem.

The research is an expansion of earlier work with a metabolic model of corn roots that the same team used to study the plant's nitrogen-use efficiency under nitrogen stress conditions, said Rajib Saha, Richard L. and Carol S. McNeel associate professor of chemical and biomolecular engineering and principal investigator.

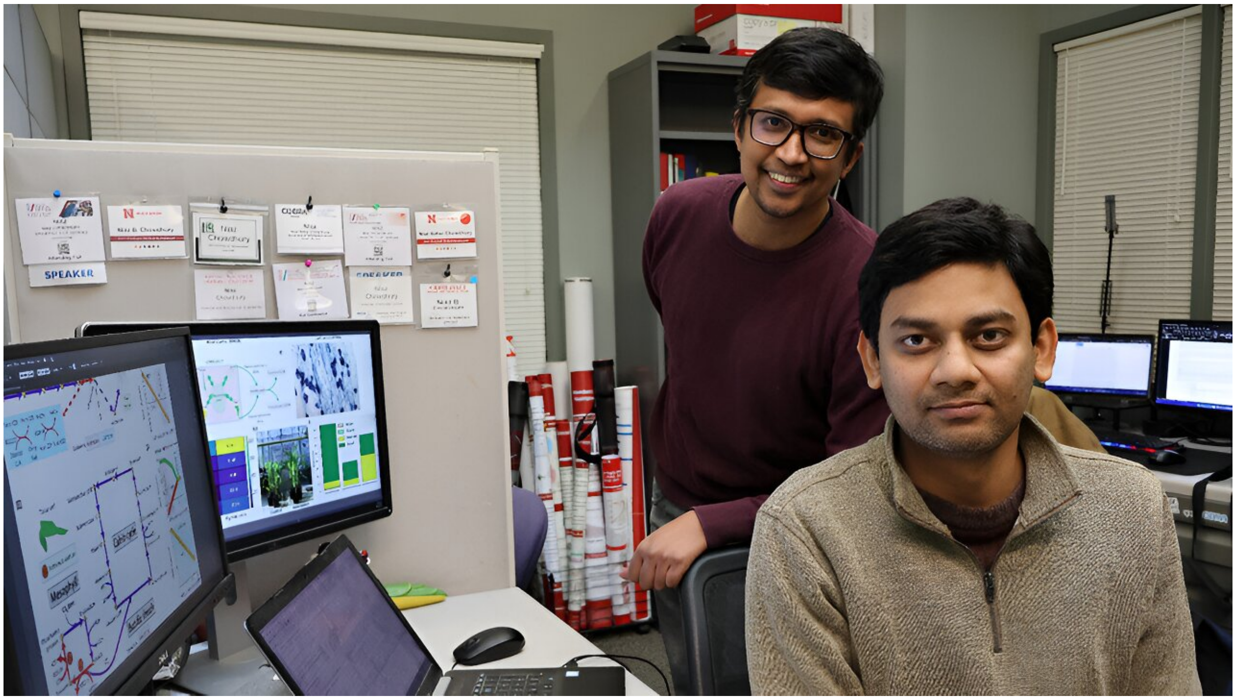
Saha and the team have expanded the model to comprise the entire plant, not just the roots, allowing for expanded research into the intricate metabolic interactions, their associated molecular underpinning and a variety of stressors that can affect productivity. The findings are published in the journal *iScience*.

The metabolic model is of corn hybrid B73, whose genome is highly prized for making hybrids that are used for food, feed and a variety of industrial uses. Developed at Iowa State University in the early 1970s, this line and its descendants are present in half the parentage of nearly all hybrid corn grown around the world.

The Nebraska-developed multi-organ metabolic model—the largest ever created of corn (or any other plant)—allows scientists to conduct research more efficiently and quickly than field research using actual corn plants. The model can also help field researchers with actual corn plants conduct experiments faster and more efficiently, said Niaz Bahar Chowdhury, a doctoral student working with Saha.

It's estimated that temperature stress resulting from climate change can reduce corn productivity by 7% to 18%.

"There is a pressing need to develop high-yielding maize genotypes capable of withstanding temperature stress," Saha said.



Rajib Saha (left), Richard L. and Carol S. McNeel associate professor of chemical and biomolecular engineering, and Niaz Bahar Chowdhury, doctoral student. Credit: Craig Chandler | University Communication and Marketing

Scientists are focusing on how plants' metabolism can be adjusted to counteract that stress. The team's study takes a holistic, plant-wide approach rather than looking only at specific elements of the plant, Saha said.

Among other impacts, temperature stress can reduce photosynthesis and carbohydrate synthesis in leaves, reduce starch synthesis in kernels, and affect amino acids and lignin biosynthesis in stalks. Also, temperature stress can damage enzymes and tissues, impair flowering and trigger oxidative stress at the reproductive stage.

Saha's team expressed excessive heat and cold data into their model, finding that both created so-called "metabolic bottlenecks" that slowed plant growth, but noting that heat was especially problematic. Excessive heat is expected to continue impeding crop growth amid ongoing climate change.

One approach to mitigate temperature stress is to reengineer the plant, creating new hybrids that are less affected by it. While that can be successful, "it's a very, very long process," Saha said.

In the other approach, researchers inoculated corn root with a beneficial fungus known as Rhizophagus irregularis, commonly used as a soil inoculant. The new study found that R. irregularis also was successful in reducing metabolic bottlenecks that slow plant growth under heat and cold stress conditions, Saha said. Both whole plant biomass and organ-specific biomass growth rates increased with the fungal treatment. Future research, using the same metabolic model, will focus on how R. irregularis affects plant metabolism under high- and low-nitrogen conditions.

Chowdhury and Saha said the model they have created will be available to researchers who want to study other stresses on corn.

More information: Niaz Bahar Chowdhury et al, A multi-organ maize metabolic model connects temperature stress with energy production and reducing power generation, *iScience* (2023). DOI: 10.1016/j.isci.2023.108400

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