Press release

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A prion-related protein senses warmer temperature in plants

Many plants and trees flower in the spring when it gets warmer. How plants sense temperature has been a long-standing question. In a recent discovery, an international team led by Prof. Philip Wigge of the Leibniz Institute for Horticultural and Ornamental Crops (IGZ) in Großbeeren, Brandenburg sheds light on this mystery.

Scientists from the UK, France, Korea and Germany focused on a protein called EARLY FLOWERING3 (ELF3). ELF3 is a key part of the circadian clock and is necessary for plants to respond correctly to changes in temperature. In the model plant Arabidopsis (thale cress), ELF3 responds to temperature directly. In mild temperatures, it switches off genes during the night, and therefore slows down growth and flowering. When it gets warmer however, ELF3, no longer turns off its target genes. This effectively releases the brakes on growth and flowering, enabling cell expansion and flowering.

Writing in the journal *Nature*, the team shows that ELF3 has a sequence related to prion proteins. Prions are proteins that occur in two states, a soluble form and a highly condensed multimeric form, and are most well known for being connected to diseases such as bovine spongiform encephalopathy (BSE), known as “mad cow disease”. While prions were first identified for causing disease in humans, proteins with prion-like sequences are very common and found across the kingdoms of life from fungi to plants and animals. This raises the question of what their roles in healthy cells are. In this case, the researchers have found that the prion-related domain in the protein ELF3 acts as a reversible temperature switch. At lower temperatures, ELF3 is in the active state, repressing gene expression. As the temperature increases, the ELF3 prion-domain switches directly in response to temperature making ELF3 inactive. This enables the Arabidopsis plants to sense warmer temperature and activate flowering. Simply by replacing a region of ELF3 containing the prion sequence with the same region of ELF3 from another plant species that does not encode a prion is enough to abolish the response to warmer temperatures. In this case, the plants are healthy and grow normally but no longer flower early under warmer temperatures.

While the main research was done on the model plant Arabidopsis, it is important to know that proteins, such as ELF3, with prion domains are found in all plants, including crops. These proteins may therefore be key candidates for plant breeding programs. As the climate heats up, crop yields will decline in many parts of the world because heat stress affects flower fertility, grain quality and plant fitness.

“How plants sense temperature is a key question, and is particularly relevant in the context of climate-change.”, says lead scientist Prof. Philip Wigge. “Our finding that the ELF3 prion domain is key to temperature response suggests that prion domain proteins may play a general role as environmental sensors. While they are often implicated in disease, prions also must have a useful role in the cell. Their ability to reversibly switch between the active and inactive states makes them ideal as environmental and temperature sensors.”

Nature article: https://www.nature.com/articles/s41586-020-2644-7

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