New biochemical pathway that may develop more resilient crop varieties

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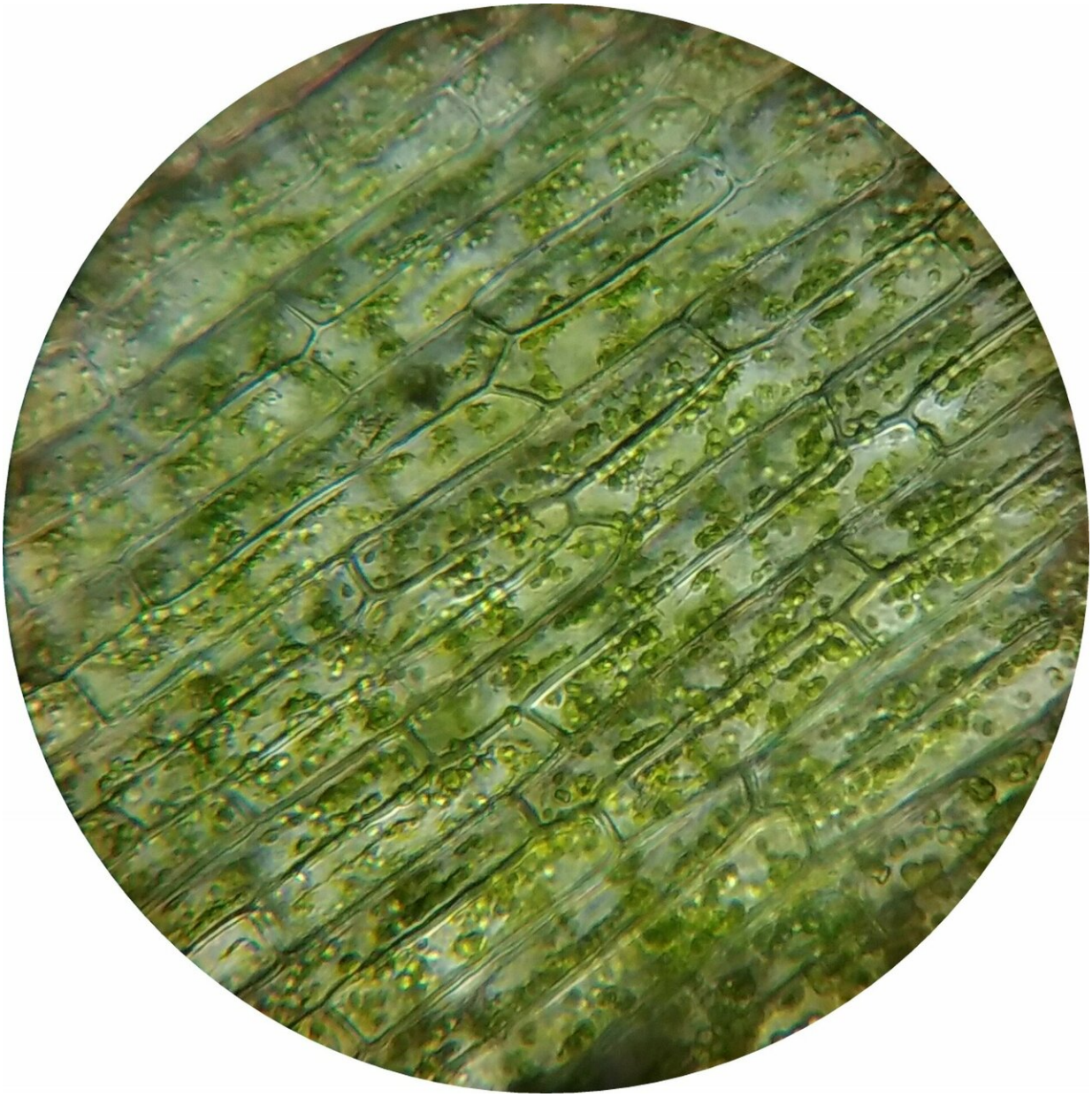

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Researchers from the Department of Plant Sciences, University of Oxford, have discovered a new biochemical pathway in plants which they have named CHLORAD.

By manipulating the CHLORAD pathway, scientists can modify how plants respond to their environment. For example, the plant's ability to tolerate stresses such as high salinity can be improved.

The researchers hope that their results, published in *Science*, will open the way to new crop improvement strategies, which will be vital as we face the prospect of delivering food security for a population that is projected to reach nearly 10 billion by 2050.

The CHLORAD pathway helps to regulate structures inside plant cells called chloroplasts. Chloroplasts are the organelles that define plants. Along with many other metabolic, developmental and signalling functions, chloroplasts are responsible for photosynthesis—the process whereby sunlight energy is harnessed to power the cellular activities of life.

Consequently, chloroplasts are essential, not only for plants but also for the myriad ecosystems that depend on plants, and for agriculture.

Chloroplasts are composed of thousands of different proteins, most of which are made elsewhere in the cell and imported by the organelle. These proteins must all be very carefully regulated to ensure that the organelle keeps functioning properly. The CHLORAD pathway works by removing and disposing of unnecessary or damaged chloroplast proteins; hence the name CHLORAD, which stands for "chloroplast-

associated protein degradation".

Professor Paul Jarvis, lead researcher, said: 'Two decades on from the identification of the chloroplast protein import machinery—which delivers new proteins to chloroplasts—our discovery of the CHLORAD pathway reveals for the first time how individual, unwanted proteins are removed from chloroplasts.'

Researcher, Dr. Qihua Ling, said: 'Our previous studies showed that proteins in the chloroplast membranes are digested by a protein degradation system outside of chloroplasts. So, the key question was: How are chloroplast proteins extracted from the membrane to enable this to happen? Our discovery of the CHLORAD system answers this question, and we identified two novel proteins that act in the process.'

Co-researcher, Dr. William Broad, added: 'Chloroplasts are eukaryotic organelles that originated more than a billion years ago from photosynthetic bacteria, by a process called endosymbiosis. Remarkably, the CHLORAD system contains a mix of components of eukaryotic origin and bacterial origin. This provides a fascinating example of how eukaryotic host cells have evolved gradually, co-opting available tools in novel ways, to govern their endosymbiotic organelles.'

Peter Burlinson, Frontier Bioscience Lead at the Biotechnology and Biological Sciences Research Council, said: 'The discovery of this biochemical pathway is a good example of how insights from fundamental plant biology research can reveal potential new strategies to develop crops that are more productive and resilient. This helps illustrate the value of basic science in contributing to addressing key global challenges including a rising global population, environmental stresses and an increased demand to deliver food security.'

By the year 2050, the current level of food production must increase by

at least 70% to meet the demands of a growing world population and shifting dietary preferences towards more animal products, while 38% of the world's land and 70% of fresh water are already used for agriculture. Abiotic stresses, including drought, high and low temperatures, soil salinity, nutrient deficiencies, and toxic metals, are the leading cause of yield loss, decreasing crop productivity by 50-80% depending on the crop and geographical location.

Thus, developing stress-resistant crops that can have stable yields under stress conditions is an important strategy to ensure future food security. This need is particularly urgent considering the increased frequency of extreme weather conditions that accompany global climate change, which cause more severe environmental stresses, more frequent plant disease outbreaks, and reduced yield and harvest quality.

Oxford University Innovation (OUI), the University's research commercialisation arm, is managing the technology.

More information: "Ubiquitin-dependent chloroplast-associated protein degradation in plants" *Science* (2019). science.sciencemag.org/cgi/doi … 1126/science.aav4467

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