Scientists uncover a novel mechanism that regulates carbon dioxide fixation in plants

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A team of Biotechnology and Biological Sciences Research Council (BBSRC) funded scientists at the University of Essex has discovered a new mechanism that slows the process of carbon dioxide fixation in plants.

The research, published today in the *Proceedings of the National Academy of Sciences*, increases our understanding of this process, which may ultimately lead to crop improvement and 'fourth generation' biofuels. The mechanism, which helps to regulate the way in which plants absorb carbon dioxide (CO2) from the atmosphere and turn it into sugars, acts by putting the brakes on sugar production when there is not enough energy from sunlight available. As sunlight increases, the brakes are rapidly released and carbon dioxide fixation speeds away.

Plants are dependent on sunlight to capture carbon dioxide, which is turned into important sugars via a process called the Calvin cycle. As a result, as the amount of sunlight varies during the day (e.g. through cloud cover or shading from other plants), they must also be able to vary the speed at which they capture carbon dioxide from the atmosphere.

This ensures that when there is a lot of sunlight, it is taken full advantage of but that when sunlight drops, so does CO_2 uptake. This ability to maximise energy use is important for plants and prevents the loss of important metabolic resources. Because they essentially stay in one place, plants must have many unique abilities to adapt to their environment as it changes around them.

The question is how does this variable speed control actually work" The BBSRC-funded research shows for the first time how the Calvin cycle can be regulated in response to a changing light environment via a molecular mechanism. There is a special relationship between two enzymes that are involved in the Calvin cycle – phosphoribulokinase (PRK) and glyceraldehyde-3-phosphate dehydrogenase (GAPDH). When light levels decrease, the two enzymes tend to stick together and therefore cannot function, thus slowing the Calvin cycle. The darker it is, the more PRK-GAPDH partnerships are formed and the slower the Calvin cycle becomes. In the light, they break apart rapidly and the Calvin cycle is allowed to speed up.

This fundamental research has revealed a novel mechanism and provides a better understanding of the regulation of CO_2 fixation in plants. This work will underpin strategies to increase the amount of carbon dioxide absorbed by plants thereby increasing yield for food and biofuel production, and may ultimately feed into the development of 'fourth generation' biofuels.

Research Leader, Professor Christine Raines of the University of Essex, said: "Although this research focuses on the fundamental biological processes that plants use, ultimately, if we can understand these processes, we can use the knowledge to develop and improve food and biofuel crops."

Dr Tom Howard, who contributed to the research, said: "Plants have evolved a fascinating way to cope with variations in their local environments. Unlike animals, they cannot move on to look for new food sources. This research helps to unlock one way that plants deal with the ultimate variable – the amount of sunshine they receive."

Professor Nigel Brown, BBSRC Director of Science and Technology said: "With a growing world population and increasing demands for

energy we need to consider new ways to improve food and fuel production. Sophisticated basic research in areas which have been studied for many decades, such as this work funded by BBSRC, furthers our understanding of natural processes that have the potential to be harnessed to meet future challenges."

Source: Biotechnology and Biological Sciences Research Council