Plants tell time

June 4 2013, by Anthony King

Scientist Peter Freeman is managing a project that is probing the clock and metabolism of plants, called TiMet. Partners to the project include star biologists in the Germany, Spain, Switzerland and the UK, all working to gain better insights into what make plants tick.

Here, Freeman talks to youris.com about how understanding the systems behind key traits can allow us improve plant breeding via precision genetic engineering and crop management. Ultimately, this will optimise yield and quality.

Is it true that project scientists are mainly relying on a lowly weed for their studies?

The project uses the thale cress, whose scientific name is Arabidopsis thaliana, a lot. It is a fairly inconspicuous little weed. But it has a relatively small genome, which has been sequenced. And it is a good analogy for other more complex plants. Thale cress can be put through its paces quickly. It therefore gives you insights into commercial crop plants that would take far longer and require far more area to grow.

Do plants really have internal clocks and if so what do they need them for?

Plants need to anticipate cycles of light and dark and adjust their metabolism accordingly. There's no point trying to photosynthesize in the middle of the night when there is no sunlight. And plants need to be ready to go first thing in the morning as the sun rises, rather than wait until the sun is up. So they are not reactive; they anticipate. Genes turn on at the right times. If you move a plant to a greenhouse with constant light they will stick to the night-day cycle they adjusted their clock to. That is similar to jetlag in humans.

Does our internal clock have anything in common with plant clocks?

There is a lot of conservation of clock genes among organisms, but some are more complicated than others. When you get up to a human or other mammal there are many clock components, with core clocks and peripheral clocks working together to coordinate all sorts of functions. At the genetic level we are closer to plants than we might think. Our genes do share similarities.

You have adopted a systems biology approach to understand the inner mechanism of plants: what's that mean?

We take a holistic view and use modern data crunching to view internal mechanism within plants, which are complex systems. Traditionally science would break down or grind up a plant and extract and characterise various parts such as enzymes. We are looking at lots of individual proteins and plant communication networks and at how all these nuts and bolts come together and interact to produce an emergent property like good growth or high yield in a cereal crop.

How can understanding plant clocks and metabolism help us?

You want the plants to be optimised, whether it is growing plants that produce biofuels or food crops. Today, the full genomes of many crop plants have been deciphered. But we still have to find out how the genes work together and regulate each other, as it influences the way they are expressed and ultimately what proteins they produce. Understanding that will allow us do more complex adjustments of their genetic make-up to improve yields. But also to understand secondary metabolites and traits like colours, fragrances and disease resistance.

You are looking at starch metabolism and something called isoprenoids: what are they?

These are organic compounds plants make and they are used in esoteric plant metabolic pathways that make things like colours and fragrances. These pathways are very complicated and not well understood. We are asking how the clock influences the pathway, but the guys working on the pathway are also investigating its effect on the clock. They are asking which pieces are missing from our jigsaw.

How does your crop improvement strategy differ from how we improved crops before?

What we are doing here is a bit like precision engineering rather than "hoping for the best" engineering. In the past for conventional breeding we selected those plants that grew taller, or had a greater weight of grain or had a flavour or chemical we liked. But really this was done without a lot of knowledge. It stands to reason if you understand how it works, you can go in and adjust traits with a proper understanding of what you are doing.

Can this project's research better prepare us for

climate change?

This project should provide broader insights for scientists but also for companies trying to breed new traits into crops. This means being better able to grow plants with lower fertiliser inputs for example. This would save money and be good for the environment. It would also allow us breed crops better at dealing with so-called abiotic stresses—like salinity and drought— and dealing with challenges that a changing environment will throw at crops. Adaptability will be key to facing up to climate change and knowing the mechanisms that confer adaptability in plants will be vital.

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