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CT scanning shows why tilting trees produce better biofuel

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Tilted willow trees. Credit: Imperial College London

Imperial researchers have used medical imaging techniques to explore why making willow trees grow at an angle can vastly improve their biofuel yields. Using micro-CT scans, the team showed that the trees respond to being tilted by producing a sugar-rich, gelatinous fibre, which helps them stay upright.

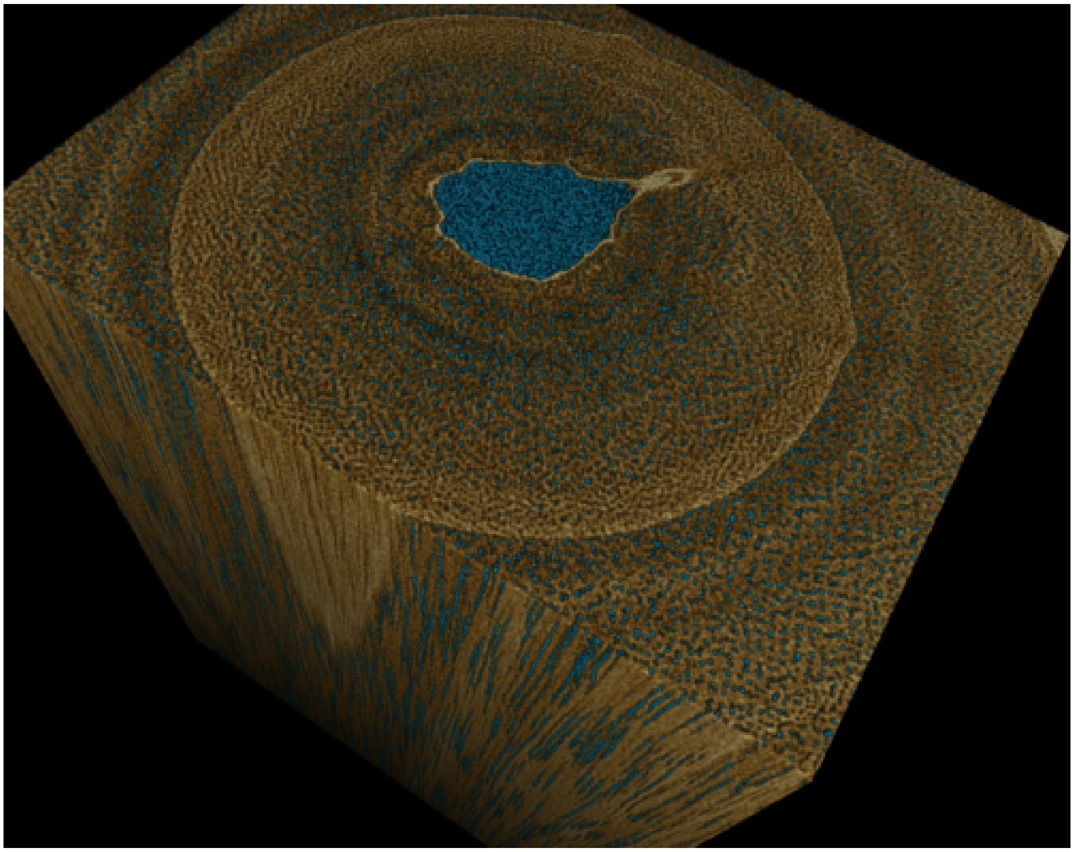
Willows are suitable for widespread cultivation as biofuels because they produce large quantities of accessible sugar, are fast-growing and can tolerate harsh environmental conditions, such as windy slopes and poor soil. In fact, trees grown in harsher conditions or polluted soil can even produce better biofuel because the sugar they produce is more accessible, requiring less energy to harvest it.

Growing the willow trees at a 45-degree angle simulates this natural stress, encouraging the trees to produce up to five times more sugar than plants grown normally. But exactly why and how this happens has not been clear until now.

Researchers at Imperial College London worked with experts at the Natural History Museum, the University of Surrey and Rothamsted Research Centre to use X-ray micro-computed tomography (CT scanning) to examine the willow's growth through high resolution 3D images.

This enabled them to see the changes in the willow at a cellular level and how they affected the plant's growth. They found that tilted willows prolonged the life of certain cells in order to produce a sugar-rich, or gelatinous, fibre, to help them stay upright. The team were able to measure how much longer the cells needed to stay alive to produce the special fibre.

"It was difficult to see why the trees were releasing so much more sugar when stressed in nature or grown at an angle. Being able to visualise the differences occurring at a microscale, or cellular level, allowed an insight into the biology behind the macroscale effects on the whole tree," explains Dr Nicholas Brereton, from Imperial's Department of Life Sciences.



CT scan of tree fibre and vessels. Credit: Imperial College London

"Willow is a great crop because it grows in really inhospitable places. It can add value to marginal land and is also useful for helping to clean up areas of polluted land," adds Dr Brereton. "Our research will help the biofuel sector select and use growing sites and conditions where no other crops can survive."

The research was funded by the Biotechnology and Biological Sciences Research Council, and published in *BMC Plant Biology*. The next step for the team will be to use even higher resolution CT scanning to investigate the gelatinous fibres in more detail. The aim will be to measure how much of the fibre is produced by different plants, which will help identify which species of willow are likely to be the world's best 2nd generation biofuel producers.

As well as being a valuable research tool, the use of CT scanning techniques to look into plants and animals is also an extremely useful teaching resource, believes Dr Brereton. He is already working with the colleagues at Imperial College to integrate 3D micro-images into undergraduate teaching.

"Students would recognise this sort of imaging from medicine, but the greatly increased resolution of X-ray micro-CT at the NHM means we can explore the biological world in a thousand times more detail, and in 3D," says Dr Brereton.

More information: "X-ray micro-computed tomography in willow reveals tissue patterning of reaction wood and delay in programmed cell death" by Nicholas Brereton (Imperial College London and Université de Montréal), Farah Ahmed and Daniel Sykes (Natural History Museum), Michael Jason Ray (Imperial College London), Ian Shield and Angela Karp (Rothamsted Research) and Richard James Murphy (University of Surrey), is published today in *BMC Plant Biology*. www.biomedcentral.com/1471-2229/15/83

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