UK Research and Innovation

How computer modelling is helping to solve Europe’s olive tree disease problem.

Have you ever noticed the white foamy “cuckoo spit” found on certain plants in the spring? It turns out it has nothing to do with cuckoos at all – it is actually produced by jumping insects called froghoppers.

Froghoppers are found all over the UK and Europe. Their larvae, often called spittlebugs, hatch inside the stem of a plant and feed on the sap flowing through its water vessels. As a by-product, they produce these frothy, protective bubble baths, which act as a defense against predators.

These spittlebugs have little impact on the health of the plants they inhabit. However, they are unwittingly playing accomplice to Europe’s number one plant health problem. Olive quick decline syndrome, caused by the bacterium *Xylella fastidiosa*, is threatening to devastate olive groves across Italy and beyond.

The bacteria lives in the water transport vessels of infected plants. It spreads via adult froghoppers, which move from plant to plant feeding on sap. As the bacteria multiplies inside the infected plant, it eventually stops water transport by blocking the vessels. The plant suffers symptoms of water deficiency, such as shriveled leaves and fruit, yellowing of vegetation and a ‘scorched’ appearance. Eventually, the plant will die.

The disease was first detected in Europe in summer 2013, when olive farmers noticed their trees displaying unusual symptoms. By December of the same year, 8000 hectares of land were affected. Less than a year later, that number had shot up to 23,000 hectares. Olive crop yields have declined by an astonishing 60% since *Xylella* was first recorded.

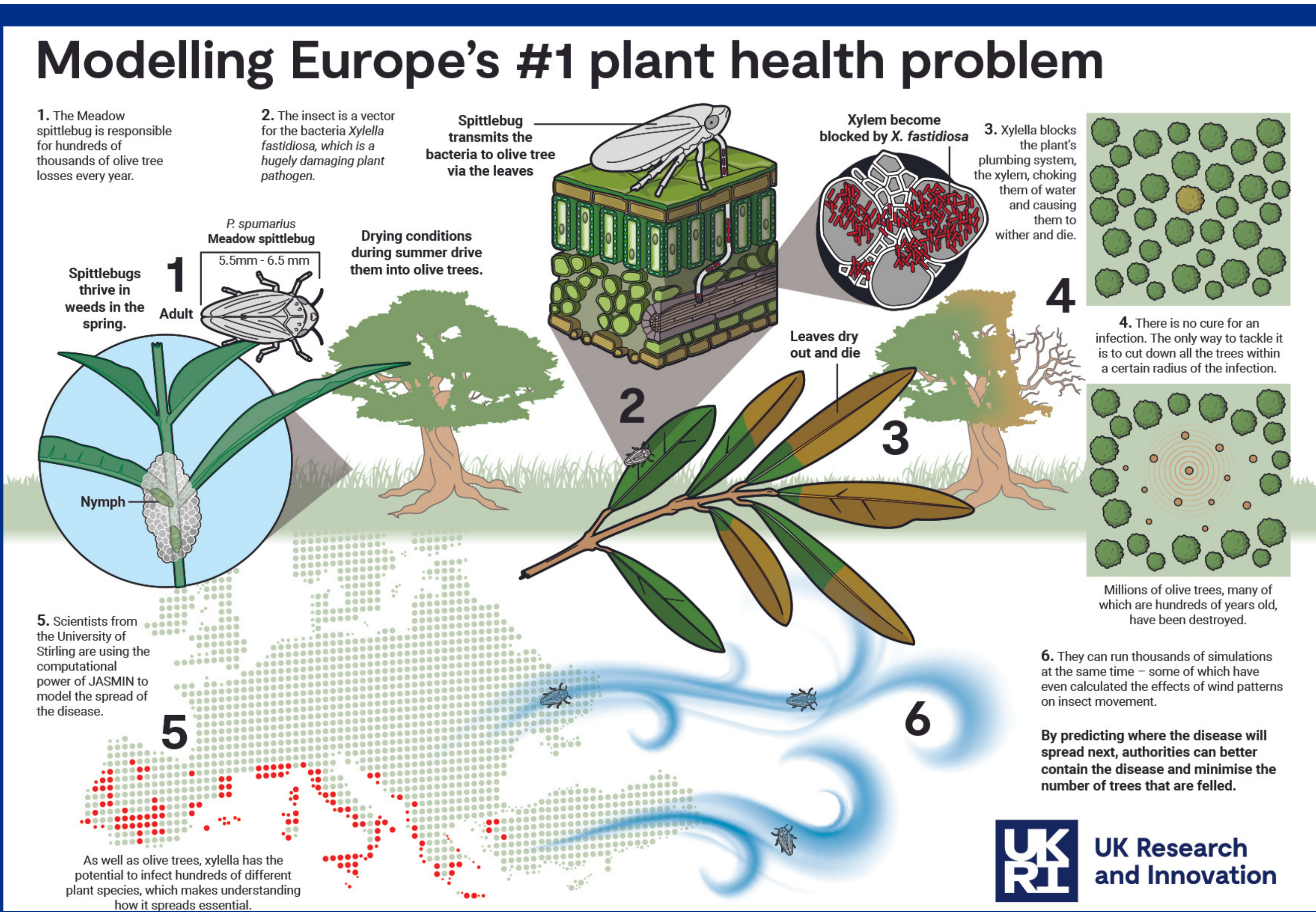
Unsurprisingly, scientists are keen to understand more about the disease. Dan Chapman, an ecologist based at the University of Stirling, leads a team that is using computer modelling to both track and predict the spread of the disease as it moves through Italy and into parts of mainland Europe. They hope this approach will help Italian authorities contain the spread of this dangerous bacterium.

"To start off, we divide the landscape of the infected region up into a grid. A map tells us where the olive groves are, so we can estimate how many trees are in each grid square," explains Dan. His team knows that the main way the disease spreads is within and around an infected grid square, tree to tree. "We can model this quite easily using a standard epidemiology model," he says. "But there's another element too.

The disease occasionally suddenly jumps a large distance – what we call a long-distance dispersal event. These jumps are much less predictable."

Dan's team is using the UK's JASMIN super-data-computer to refine their model by building it multiple times, each time with a slightly different set of parameters. They can then compare the models to real-life data, and find out which are the most accurate.

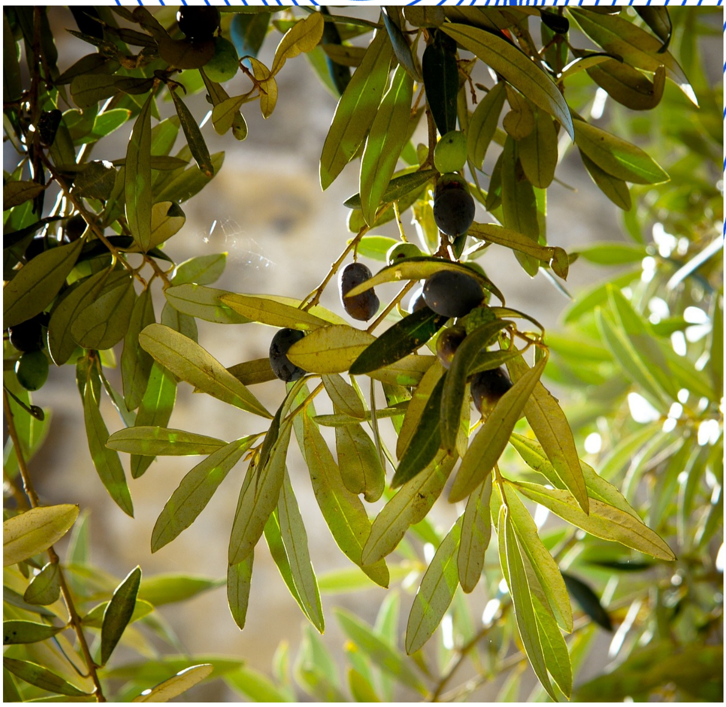
"The most basic version of the model assumes that dispersal events are totally random, but we can also investigate other scenarios for dispersal and disease transmission," says Dan. "We're currently running simulations where the jumps happen more often in the direction of the prevailing wind. We're also considering a version where the insects move along roads, hitchhiking on vehicles."



Running a single simulation takes between half an hour and two hours, and there are millions of them to run. The power of using JASMIN, Dan says, is not in speeding up running time, but in allowing thousands of simulations to run at once. “JASMIN allows scientists with basic coding skills to really scale up their work. We’re motivated by the science more than the programming.”

Using JASMIN makes it much easier for the team to concentrate on their science. Importantly, their work could help slow the spread of *Xylella* through Italy’s olive groves.

Authorities need to know which areas are the most vulnerable, so they can place them under closer surveillance. Dan’s model will predict where the next outbreak is most likely to be. Once an outbreak is detected, all of the trees in a certain radius are felled, to isolate the disease and stop it spreading further. Dan’s model has been used to suggest how big that radius should be, and investigate how other features of the disease surveillance programme may affect the containment strategy.



Although olive trees in Italy have been primarily affected by the spread of *Xylella*, the UK’s native trees may not escape unscathed if the disease hitches a ride to the UK. Some subspecies of *Xylella* already present in Europe are able to infect cherry, elm and oak.

The research team collaborates with the European Food Safety Authority who provide information and guidance for EU regulations on how to respond to *Xylella*.

JASMIN is hosted and operated by the Science and Technology Facilities Council (STFC). It is managed jointly by STFC's Scientific Computing Department and CEDA (Centre for Environmental Data Analysis), part of STFC’s RAL Space. It is funded by the Natural Environment Research Council (NERC). Both STFC and NERC are part of UK Research and Innovation.

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