Melanie Tuffen

Phytoplasmas: friend or foe?

Christmas may be over for another year, but did you know a deadly pathogen may have been lurking amongst your festive decorations? ***Melanie Tuffen*** *explains.*

The deadly Christmas decoration?

Go to any supermarket in the weeks before Christmas, and you'll see neat rows of poinsettia plants *(Euphorbia pulcherrima)* on the shelves, their scarlet bracts (modified leaves) glowing. Four million poinsettias are sold in the UK every Christmas, and 75 million are sold in the US. They're such big business, there are farms devoted to growing nothing else. But would the people throwing the plants into their shopping trolleys be as keen to buy them if they knew the secret the poinsettias hide?

The poinsettias we see in the shops are very different from the ones found in the wild, in Mexico and Central America. Wild poinsettias are often taller than a human and perhaps only produce a single flower – hardly suitable as a house plant.

When, in the 1920s, plant breeders discovered a new variety of poinsettia, covered in flowers and small enough to sit on a table, they thought they had a winner. But these traits couldn't be bred. The only way to produce the compact plants was a method called grafting, where the tissues of two different plants are fused together. The result was that the recipient poinsettias took on the characteristics of the donor plant. This had the effect of transforming the straggly wild plant into the beginnings of an industry worth hundreds of millions of pounds every year. Breeders knew the secret must be in the sap of the grafted plant, but they had no idea what it could be.

Wild poinsettias growing by the side of the road in Mexico.

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Bodie Pennisi, University of Georgia, Bugwood.org

Poinsettias are an important greenhouse crop, particularly for the Christmas market.

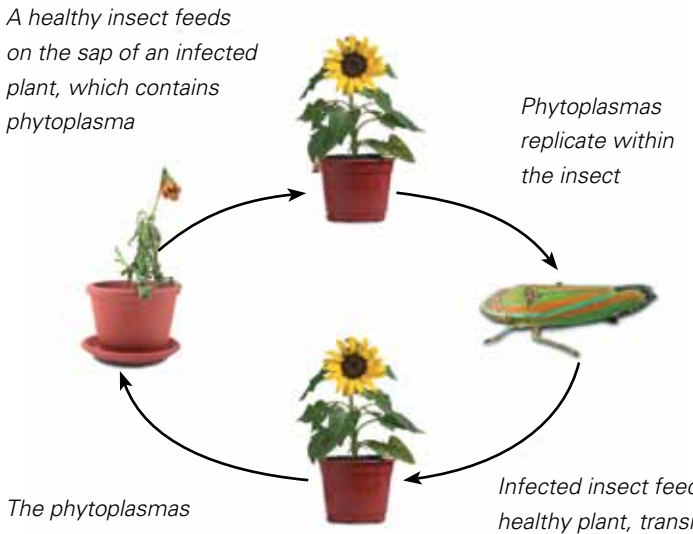
Phytoplasmas: The real Christmas star

It wasn't until 1997 that scientists discovered the secret of the poinsettia's transformation: those cheery poinsettias are actually all sick. Within the sap of the plants were phytoplasmas, a type of specialised bacteria that infects plant phloem, and damages the host plant. Phytoplasmas are normally transmitted by insects (known as vectors) that feed on plant sap. The grafted poinsettias were transmitting the phytoplasmas from the infected plant to the healthy plant through their sap.

(The phrase 'plant sap' is commonly used. Plants have two plumbing systems, the xylem, whiuch carries water, and the phloem which carries sugar solutions. The watery liquids in each can be called sap, but the sap referred to here is phloem sap.)

The diagram below shows the typical infection cycle of phytoplasmas. Insects (known as **vectors**) feed on the sap of an infected plant, also ingesting phytoplasmas. The phytoplasmas then begin to multiply in the insect salivary glands, so that when it feeds on a healthy plant, it passes the phytoplasmas to that plant causing it to become infected.

The phytoplasma infection cycle



The darker nature of phytoplasmas

Phytoplasma in poinsettias creates prettier plants perfect for our homes. But phytoplasma diseases threaten millions of people across the world, by devastating crops and leaving people hungry.

As well as the symptoms we see in poinsettia of stunting and increased branching, phytoplasmas may also cause little or no flowering (which in crop plants means no seeds, grains or fruit), can reduce leaf size, interfere in the ability to photosynthesise and can eventually kill the plant entirely.

Phytoplasmas are known to release proteins into the plant cell that enter the plant nucleus, where it is believed that they are able to change plant gene expression to cause the symptoms seen.

What does 'gene expression' mean? All genes do just one thing—they instruct the asembly of chains of amino acids, which form polypeptides, which then fold to make proteins. These proteins may act as enzymes, antibiotics, membrane proteins and many more. Genes do not always instruct amino acid assembly, they only do so when they are switched on (expressed). The switching on and off of genes is essential in the development and functioining of organisms.

A leafhopper – one example of a phytoplasma vector

Biologische Bundesanstalt für Land- und Forstwirtschaft, Bugwood.org

Grapes are an important crop which can be affected by phytoplasma diseases. Here, discoloured grapes result from the phytoplasma disease flavescence dorée.

Coconut-infecting phytoplasmas

Across the world, coconuts are a major food crop and cash crop for farmers. In Ghana, for example, coconuts are a major source of income. However, coconut palms are particularly threatened by phytoplasma diseases, which have already destroyed coconut plantations across the world. One particularly severe disease, Coconut Lethal Yellowing, causes the leaves to yellow, and the tree to die within a year, leaving just the 'telegraph poles' of dead tree trunks.

The trunks of coconut palms killed by phytoplasma disease resemble telegraph poles.

So why is the disease causing such devastation? Normally, phytoplasmas are controlled by using insecticides against the vector (the insect transmitter) of the disease. In West Africa the vector for coconut lethal yellowing is still unknown, so it cannot be controlled.

The nature of coconut farming in Africa does not help matters. Coconut farmers are smallholders and not large companies – they do not own many trees and cannot afford to cut them down even if they become infected. This gives the disease further opportunity to spread.

Phytoplasma research in the field

Phytoplasma disease is a problem in many countries across the globe, and scientists are working together to try and address this.

Collaboration includes creating links between labs in Africa, Europe, America and South East Asia – all regions where phytoplasma disease occurs. Scientists go out into the field to examine infected plants, and to help and advise farmers affected by disease.

Ndede Yankey from Ghana's Coconut Research programme with Dr Philip Swarbrick from the University of Nottingham in the field examining diseased trees.

Phytoplasma research in the lab

Very little is actually known about phytoplasmas, and how they cause disease in plants. There is no current cure, and though antibiotics can be used to treat bacterial infections in plants just as in humans, they do not kill phytoplasmas; the disease is only slowed in response to treatment. Many farmers in developing world countries can not afford to use antibiotics on their plants.

Scientists are working on tackling phytoplasma disease on multiple fronts. Some are trying to breed resistant plants, studying the genetics of plants in the field which survive when their neighbours succumb to the disease. Other scientific groups are trying to discover what phytoplasmas actually do to the plant – do they secrete toxins? Interfere with the plant hormones? Or are the plants weakened because the bacteria are using up the sugar it makes during photosynthesis?

They might produce beautiful plants for our home at Christmas, but sadly phytoplasma infection in poinsettias is the only example of phytoplasmas being beneficial to us. So perhaps when you see poinsettias next Christmas, you'll remember their dark secret, and if you bring one home make sure you look after it – after all, it is a bit poorly!

Melanie Tuffen is researching phytoplasmas at the University of Nottingham.