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Controlling resilient plant viruses with steam

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Combining steam with heat-producing chemicals could control pathogenic viruses in soil, finds new research. The study examined how effective different forms of heat sterilisation of soil were at inactivating three plant viruses. While steam alone was enough to eradicate two of the viruses, the highly resilient tobacco mosaic virus required the addition of exothermic chemicals to reduce it by 97%.

Injecting the chemical methyl bromide into soils, which can be carried out on large soil surfaces, was a highly effective method of sterilising soils, and killing off pests. However, while methyl bromide has been widely used — and still is in countries outside Europe — for this purpose, as well as to fumigate wood products and packaging, it is also an ozone-depleting and poisonous chemical now controlled under the Montreal Protocol. As such, its use is being phased out, although there have still been some successful instances of lobbying for critical-use exemptions after the Protocol's 2010 deadline.

Among the possible alternatives is heat sterilisation, using steam or 'solarisation'. Steam sterilisation involves the active injection of steam into soils over less than an hour, while solarisation uses the sun to passively heat soil underneath a transparent covering. Both methods heat the soil sufficiently to kill a range of pathogens. However, these approaches have not been evaluated for their ability to control resilient viruses, such as the tobacco mosaic virus.

This research examined how effective combining soil steaming with exothermic chemicals was at controlling three different plant viruses of commercial importance. The effectiveness of solarisation, with coverings with different thermal properties, was also tested.

Mesh bags containing soil mixed with three plant viruses — tobacco mosaic virus, potato virus Y and cucumber mosaic virus — were placed in soil at depths of 20 cm and 40 cm.

Soil solarisation was tested using three different types of plastic films: transparent polyethylene, ethylene-vinyl acetate and an 'infrared film'. The films were used to cover the soil for 20 days during July. The researchers also set up a control plot, without any covering.

Solarisation did not have any effect on any of the viruses at 40 cm depth, compared with the uncovered control plot, and the tobacco mosaic virus was unaffected even at 20 cm. The cucumber mosaic virus was eliminated at 20 cm depth in all solarisation plots, but this was also true for the control plot. The potato virus Y was completely eradicated at 20 cm by ethylene-vinyl acetate and infrared film coverings.

The researchers also carried out soil steaming either with just steam or using potassium hydroxide or calcium oxide, which both release heat when exposed to water. Following steam treatments, neither potato virus Y nor cucumber mosaic virus were capable of causing infections, regardless of depth or chemical used. Adding the chemicals caused a significant decrease in the ability of the tobacco mosaic virus to cause infections, from around 50–60% to below 3%.

The researchers also tested solarised and steamed soil to see how either treatment affected the microbial communities (e.g. bacteria and fungi) in soil, some of which can be beneficial for growing plants. They found that while both treatments reduced the amount of microbes (microbial biomass); the diversity of microbes appeared to remain the same as in untreated soils.

Tobacco mosaic virus is an extensively studied 'model' virus known to be an extremely hardy and difficult to control. As such, the finding that adding exothermic chemicals to steam treatments may offer a new way to control it, and could indicate a potentially less poisonous method in the control of similarly hardy agricultural pests.