The battle against *Fusarium* wilt fungus

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Silicon traditionally is not considered an essential plant element but there is increasing evidence indicating that silicon may have an important role in plant defence against pathogens. As one of the Earth’s most abundant elements, it is difficult to exclude silicon from any tests; silicon can be found in soils, in water, in glass and even in dust! Although it is abundant in the soil, silicon is only available to plants in certain forms and when taken up it is believed to be polymerised and no longer mobile within the plant.

Several publications to date have indicated that the addition of compounds such as Kasil (potassium silicate) and wollastonite, which is a calcium silicate mineral, enhances plant growth and reduces the effects of certain pathogens including fungi, bacteria, viruses and insects. Our initial studies with banana in pot trials have indicated that the application of silicon can reduce levels of *Fusarium* wilt. We also found that treating tissue-cultured plants with silicon may produce a long lasting response which renders plants more resistant when challenged with the *Fusarium* wilt fungus several months after silicon treatment.

In our current study we are investigating what form of silicon is most suited for use in tissue culture and post tissue, and for how long the beneficial effects of the silicon last.

We are trialling this using banana plants in pots which are challenged with the *Fusarium* wilt fungus when they are about 12 weeks out of tissue culture. We ultimately hope to test this over a longer period of time and eventually in the field.

One way we can assess what is going on is by looking at what genes are being switched on by the plant following these various silicon treatments.

When a plant is challenged with a plant pathogen, such as the *Fusarium* wilt fungus, it generally responds by switching on an array of genes known as defence genes. Defence genes either produce anti microbial proteins directly or set off a cascade of biochemical pathways leading to the production of other protective chemicals that act by containing or inhibiting the growth of the pathogen.

The faster and greater the response of these defence genes, the better the chance the plant has of resisting the pathogen.

There are indications that silicon is involved in ‘tweaking’ this defence response system (priming) so that when the plant encounters the *Fusarium* wilt fungus it is able to act faster and with a greater response in curtailing the fungus. In our studies we are examining defence gene expression with different silicon treatments combined with inoculations of the *Fusarium* wilt fungus; this should give an indication of the most effective treatments that we would hope to take on to field trials.

Another possible role for silicon in plant defence is that it may be forming a physical barrier within the plant root tissues and thus preventing fungal penetration. Kevan Jones, a PhD student at The University of Queensland, is using electron-microscopy to study the infection process of the *Fusarium* wilt fungus in banana roots, comparing plants treated with silicon with those not receiving an additional silicon treatment. So far he has observed differences to the fungal structure even as early as the point of infection into the root.

The defence gene and microscopy studies will allow us to determine the best form of silicon to apply, at what stage in the plant...
is there to be won
development and how often we should apply it in order to obtain the best protection. We will also be able to test both race 1 and sub tropical race 4 of the Fusarium wilt fungus against different banana varieties to ensure that the silicon treatments works in these different combinations. Field trials would then be our ultimate aim.

Silicon may also be beneficial in mitigating other serious diseases of banana including yellow and black Sigatoka, weevil borer, and virus-transmitting aphids. While our work focuses mostly on Fusarium wilt, the possibility of silicon affecting these diseases and pests needs to be explored.

The war-winning weapon against Fusarium wilt in banana is always going to be genetic resistance but until that is available, silicon applications may have the potential to reduce symptoms and yield losses and at least allow us to win some battles. We now need to progress this work with further lab and pot plant trials and most importantly in the field.

Research is being undertaken at The University of Queensland in conjunction with the QPIF tissue culture labs at Nambour.

Figure 1: Treatment of banana plants with Kasil appears to influence the Fusarium fungus when it attempts to infect the banana roots. The electron micrograph on the left shows the fungal cell wall (FCW) of hyphae (fungal filaments) growing in association with water (control) treated plant (A) showing three distinct layers (arrows): an electron opaque layer (top), a lighter, more diffuse layer (middle) and another electron opaque layer (bottom). The image on the right is from a Kasil treated plant and the thickness of the fungal cell wall is very much reduced with the three layers becoming indistinct. Anti-fungal enzymes produced by the plant, such as chitinase, have been previously associated with this kind of response. The presence of the silicon could be up-regulating the enzyme production and so rendering the plant more resistant to the Fusarium. (x 50,000 magnification)