UPDATES IN MANAGING RED NEEDLE CAST

Phosphite fungicides have the potential to be an effective treatment for controlling the disease red needle cast in radiata pine, which is caused by the microorganism *Phytophthora pluvialis*.

RED NEEDLE CAST

Unexplained needle cast events in pine trees have been seen in planted forests in New Zealand since at least the 1950s.

In May 2008, a routine forest surveillance check on the East Cape of the North Island found green needles with unfamiliar dark bands, or lesions. Researchers at Scion visited the site in July and named this potentially new disease red needle cast (RNC), based on the needles turning red and being easily detached.

An unknown species of *Phytophthora* was confirmed in needles collected from the affected trees shortly afterwards. In 2012, DNA sequencing matched it with that of *Phytophthora pluvialis*, a newly described species from Oregon, USA, where it is not associated with disease. A second species, *Phytophthora kernoviae*, has also been recovered from diseased needles[1].

CHEMICAL CONTROL

Severe RNC events can slow tree growth and increase rotation length, making it urgent to find ways to manage outbreaks in radiata pine stands.

Scion initiated a programme to control the disease. An important part of that programme was to develop a cost-effective, Forest Stewardship Council-compliant, chemical control method to manage outbreaks.

Phosphorus acid (phosphite) fungicides are used worldwide to control disease caused by *Phytophthora* species. Preliminary work at Scion has confirmed that phosphite is effective at reducing *P. pluvialis* and *P. kernoviae* lesions on pine needles. Further work using foliar sprays showed a 2% phosphite solution significantly reduced lesions caused by *P. pluvialis* for up to eight months after application and those caused by *P. kernoviae* for 12 months.

[1] Dick, M. A., Williams, N. M., Bader, M. K.-F., Gardner, J. F. and Bulman, L. S. (2014). Pathogenicity of *Phytophthora pluvialis* to *Pinus radiata* and its relation with red needle cast disease in New Zealand. *New Zealand Journal of Forestry Science*, **44**:6,

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The effect of adding adjuvant chemicals to the phosphite spray mix to improve pesticide spray deposition, retention on foliage and uptake was also investigated. The best adjuvant identified was an organosilicone blend Du-Wett (Etec Crop Solutions Ltd, Auckland) that increased phosphite uptake nine fold compared to the active ingredient used alone[2].

While this was a great outcome, subsequent work with our collaborators, Plant Protection Chemistry, has indicated that this adjuvant is being degraded by the phosphite, rendering it inactive within an hour or less after mixing. Effectively, the beneficial aspects of improved uptake provided by the adjuvant are being lost soon after the phoshpite solution is mixed.

Phosphite sprayed onto radiata pine foliage at application rates of 3 and 12 kg ha^{-1} may be an effective treatment for both *P. pluvialis* and *P. kernoviae*. However, a better understanding of the relationship between uptake, dose and subsequent persistence is needed before making recommendations on effective, low cost operational application rates.

LOOKING TO THE FUTURE

In the near term, research will be focussing on finding a stable adjuvant that can optimise uptake of phosphite into radiata pine foliage. Once a suitable adjuvant is identified, the full dose response relationship will be determined. Field scale dose response trials will follow to determine efficacy at an operational scale. Whether or not phosphite can control the disease in trees already infected will also be investigated.

Other chemicals may also be effective. Copper fungicide, which is already used to control dothistroma needle blight, performed well in lab-scale work. However, concerns about the effectiveness of copper in terms of persistance on pine needles need to be allayed before it can be recommended for management of RNC.

In the longer term, selective breeding for tolerance to *Phytophthora* looks to be a viable option for managing RNC in radiata pine forests. A recent assessment of six-year-old radiata pines (15 clones from each of 100 families) affected by RNC found that needle loss due to the disease is a moderately heritable trait, with observed foliage damage ranging from around 7% on the least affected trees to 40% on the most affected trees[3]. Selecting for resistance to RNC will result in improved health.

Scion and the Radiata Pine Breeding Company are working together to breed robust, disease-resistant trees.

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[2] Rolando, C., Gaskin, R., Horgan, D., Williams, N. and Bader M. K.-F. (2014). The use of adjuvants to improve uptake of phosphorous acid applied to *Pinus radiata* needles for control of foliar *Phytophthora* diseases. *New Zealand Journal of Forestry Science*, **44**:8.

[3] Dungey, H. S., Williams, N. M., Low. C. B., and Stovold, G. T. (2014). First evidence of genetic-based tolerance to red needle cast caused by *Phytophthora pluvialis* in radiata pine. *New Zealand Journal of Forestry Science*, **44**:31.