

Phosphite large tree treatment trials: brief report September 2020

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1 Introduction

Forest trials established in 2012, testing phosphite for kauri dieback (causal agent *Phytophthora agathidicida*) control, provided promising results with demonstration of a curative effect (Horner et al. 2015; 2017). However, these trials were all carried out with trees in the 'ricker' size class, mostly 15–35 cm diameter, with no testing on larger trees. Before any future deployment to treat moderate-sized trees or large iconic trees, and to allow informed decisions to be made, information on safe and effective treatment regimens for large trees is required. Doses based on trunk girth have previously been used to calculate required phosphite volumes. But with giants such as kauri, scaling up from rickers to trees with girths of 5–15 m may be difficult. Earlier trials also indicated some problems with phytotoxicity, particularly with higher phosphite rates, so it is very important that effects on larger trees are assessed before widespread release of the treatment. A balance must be struck between rates sufficient to suppress the disease, yet still safe for the tree.

In 2016, new trials were established on large kauri trees to help to determine appropriate treatment regimens, with emphasis on phosphite rates and doses lower than those used in previous trials. This report summarises trial protocols, and results of assessments made on all trial trees in August 2020, and supersedes a similar report in April 2020 (Horner & Arnet 2020).

2 Methods

2.1 Trial sites and tree selection

Three sites were selected for the trials: Puketotara Road, near Kerikeri in Northland; Trounson Park in Northland; and the Cascades in the Waitakere Ranges, Auckland. The Puketotara block is on a private land, Trounson Park is under Department of Conservation (DOC) and Te Roroa jurisdiction, and the Cascades are under Auckland Council and Te Kawerau ā Maki jurisdiction.

Trees in the trial are in the mature stage. At Puketotara, trees range in size from 0.4 to 1.1 m trunk diameter. At Trounson, trial trees range from 1.0 to 2.1 m trunk diameter, and trees at the Cascades

range from 0.6 to 2.4 m diameter. All trial trees showed symptoms of kauri dieback at the start of the trial, including basal trunk lesions.

2.2 Treatments

1. Untreated control.
2. 4% phosphite trunk injection, 20 mL every 40 cm around the trunk circumference.
3. 4% phosphite trunk injection, 20 mL every 80 cm around the trunk circumference.

Treatments were applied at the Puketotara site in March 2016 and at the Trounson and Cascade sites in November 2016. Treatment 3 applications were repeated at the Puketotara site in March 2018, and in the Trounson and Cascade sites in March 2019. Following discussions with the Kauri Dieback Programme Planning & Intelligence team, Treatment 2 was re-applied at all sites in June 2019. Re-treatment injection points were placed mid-way between previous injection points.

The determination of phosphite concentration and doses for the large trees was difficult. With trunk girth being the main determinant of dose, and with no international experience with treating trees of such size, a very conservative approach was taken. This decision was in part influenced by previous experiences with phytotoxicity. The selected phosphite concentration of 4%, with injector frequency of one every 40 cm, corresponds to the lowest rate and dose used in the concurrent 'Trunk spray and low rate trial' (Horner et al. 2019). We have also included another treatment with an even lower dose of one injector every 80-cm girth. Although this dose may be too low to provide adequate long-term control, we had the opportunity to observe effects over the first year or two, then make another application if deemed appropriate. This has now been carried out, as noted above.

2.3 Trial design

There were a total of 42 trial trees (nine at Puketotara, 15 at Trounson and 18 at the Cascades). This is double the number that was proposed in the initial trial outline, thereby providing a more robust data set. At each site, trees were divided equally among the three treatments. To ensure a relatively even distribution of disease symptoms across treatments, at each site trees were placed into groupings based on disease parameters such as lesion activity and canopy symptoms, before random assignment of the various treatments within each grouping.

2.4 Initial assessments

Before treatment, baseline assessments were made on various tree growth and health parameters. These included tree girth, canopy health score, canopy colour, plus trunk lesion size and activity. Selected lesion margins were marked for subsequent measurement of expansion, and canopy photographs were taken for later comparison.

2.5 Periodic assessments

Tree health and lesion expansion plus activity has been measured approximately every 6 months. Assessments to date have been in August 2016 for the Puketotara site and February/March 2017, August 2017, March 2018, October 2018, February/March 2019, August 2019, February 2020 and August 2020 for all three sites. The later than planned assessment in October 2018 was because of

delays in gaining permission to access sites in the Waitakere Ranges with the recent Controlled Area Notice.

Lesion activity has been scored on a scale as follows:

- 0 = not active (all bleeds hard and dry, cannot dent with fingernail)
- 0.2 = probably not active (bleeds mostly hard and dry, but possible to make dent with fingernail)
- 0.5 = probably active (slightly soft bleeds, but not very sticky)
- 1 = active (sticky bleeds, obviously recent)
- 2 = very active (copious very soft ooze)

Although this lesion activity scoring scale is slightly arbitrary, it allows unbiased assessment of each lesion, and comparison across treatments.

3 Results and discussion

It is now almost 4 years since treatments were first applied at Trounson and the Cascades sites, and 4½ years since the initial Puketotara treatment. To date, no phytotoxicity symptoms have been observed in any of the trees. At the Cascade site, two out of six untreated control trees have died, as have one of the six trees in each of the injected treatments. One untreated control tree at Trounson has steadily declined over the past 3 years and has now died. One treated tree (20 mL phosphite/80 cm spacing) at Puketotara has shown substantial canopy decline over the first 3 years (from a '2' to a '4' on the Kauri Dieback Programme canopy scoring scale), but seems to have stabilised recently. There are no obvious trends related to treatment in assessments of canopy health, either in colour change, shoot growth or canopy photo comparison. Other than the above-mentioned dead trees, there are no major changes in canopy density to date, and no sign of phytotoxicity or yellowing of leaves in any of the treated trees.

In the February/March 2019 assessment, it was noted that neither of the phosphite treatments led to complete healing of the lesions at any of the sites. Since then, phosphite treatments have been re-applied to all trees (except treatment 3 at Puketotara, which was re-treated 1 year earlier). Within 2 months of the second treatment, there was a noticeable shift in lesion activity in treated trees at all sites, with improved healing in treated trees (Horner & Arnet 2019). This was a rapid response, considering it was only 2 months since the 20 mL/40 cm treatment was reapplied. In the assessment made 8 months after the second application, the initial changes were reinforced. Now, a further 6 months on, lesion activity has remained low in most treated trees (Figures 1 and 2). However, a small number of lesions in treated trees have remained active, especially at the Trounson and Cascades site. In untreated control trees, on average, lesion activity has remained higher than in treated trees. However, in the latest assessment (August 2020) there appeared to be a drop in average lesion activity in untreated trees across sites. Reasons for this are unclear, but it is possible that the very dry preceding summer may have contributed to lesions drying up. Future assessments will determine if this is a permanent shift.

To date, this trial has shown that a single application of the low rates chosen is insufficient to adequately suppress *P. agathidicida*-lesion growth in large trees. The conservative and cautious approach with treating these big trees (in order to avoid phytotoxicity) stretched the lower limit too far. The highest rate used in this trial (20 mL of 4% phosphite injected every 40 cm) is substantially lower than the 20 mL of 7.5% phosphite injected every 20 cm in the earlier ricker trials (Horner et al 2017). While phytotoxicity symptoms seem to have been avoided, lesion healing has not been sufficient and a number of trees still have active bleeds. However, results to date suggest that a second dose of the

same low rates, 2–3 years after the initial treatment, may be effective. But more than a year after this second treatment, there are still concerns about lesion activity on some trees.

In the concurrent 'Trunk spray and low rate trial', a rate of 4% phosphite injected every 40 cm around the trunk was effective at stopping lesion activity in rickers (Horner & Arnet 2019; Horner et al. 2020). This same dose (based on trunk circumference) in the current large tree trial was not fully effective, suggesting that these large trees need a higher dose to facilitate total lesion healing and a different formula may be required. Given that there have been no obvious phytotoxicity symptoms noted to date, higher dose rates or higher frequency of application should be considered. It is interesting to note that treatment success has been better at the Puketotara site, with a much smaller average tree size, than at the Trounson and Cascade sites with larger trees.

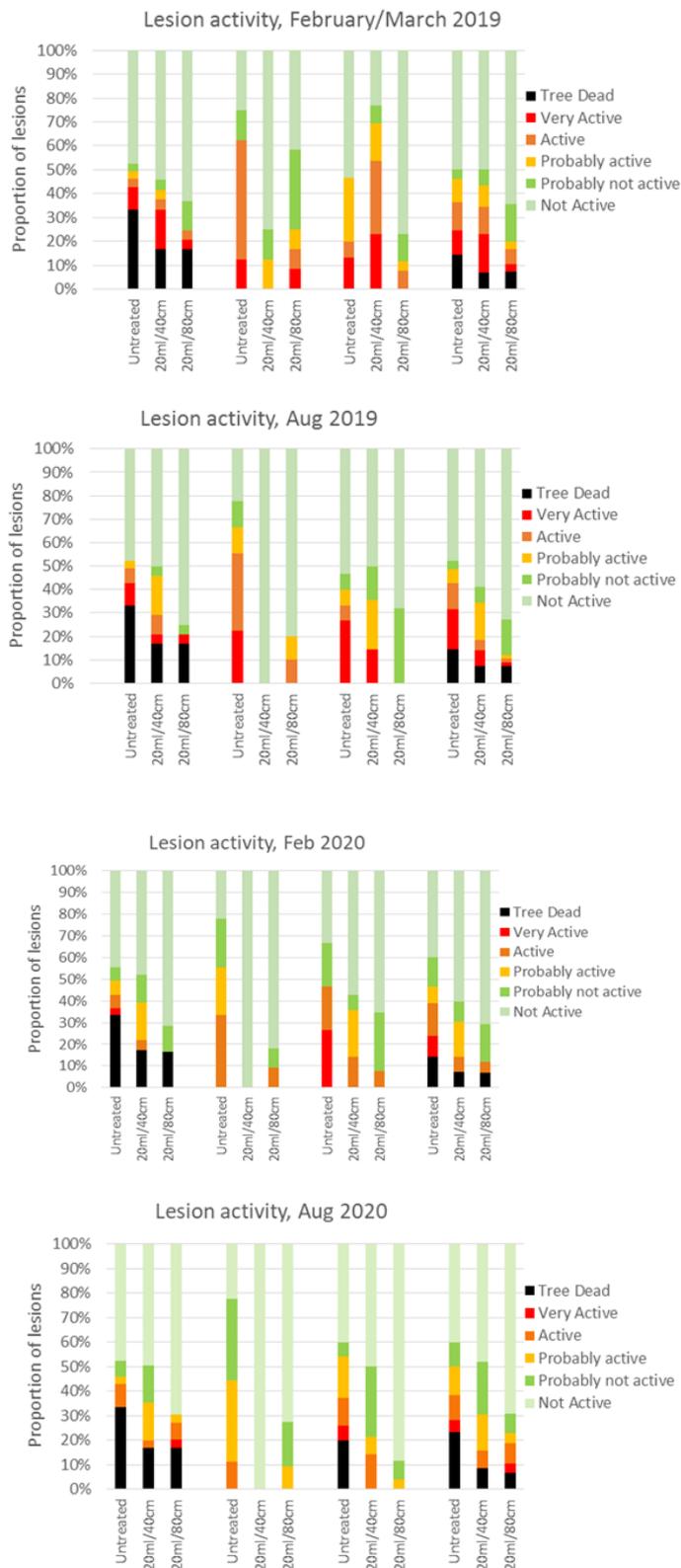


Figure 1. Proportion of lesions in various lesion activity categories, in *Phytophthora agathidicida*-infected kauri trees on three sites, assessed (from top to bottom) in February/March 2019, August 2019, February 2020, and August 2020. Phosphite injections were applied in March 2016 (Puketotara site) or November 2016 (Cascade and Trounson sites). A 4% phosphite solution was applied as one 20-mL injection every 40 cm or one injection every 80 cm around the trunk circumference. Phosphite was re-applied to trees in the low dose (4% injection every 80 cm) in the Puketotara site in March 2018 and Cascade plus Trounson sites in February/March 2019. The higher dose phosphite treatment (4% injection every 80 cm) was re-applied on all sites in June 2019.

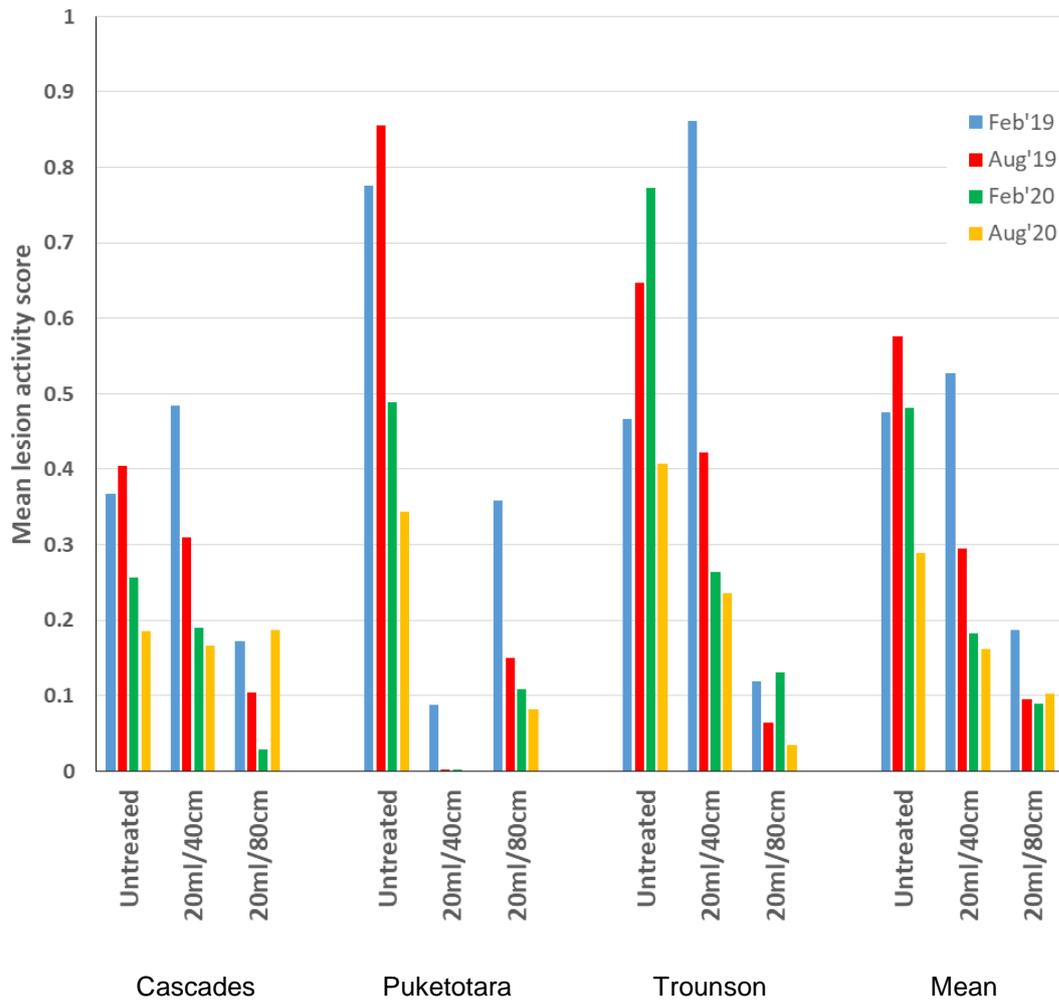


Figure 2. Mean lesion activity score, in *Phytophthora agathidicida*-infected kauri trees on three sites, assessed in February/March 2019, August 2019, February 2020 and August 2020. Phosphite injections were applied in March 2016 (Puketotara site) or November 2016 (Cascades and Trounson sites). A 4% phosphite solution was applied as one 20-mL injection every 40 cm or one injection every 80 cm around the trunk circumference. Phosphite was re-applied to trees in the low dose (4% injection every 80 cm) in the Puketotara site in March 2018 and Cascade plus Trounson sites in February/March 2019. The higher dose phosphite treatment (4% injection every 80 cm) was re-applied on all sites in June 2019. Lesion activity scoring: 0=not active, 0.2=probably not active, 0.5=probably active, 1=active, 2=very active.

4 Plans

A final six-monthly assessment of tree health, lesion activity and spread, and phytotoxicity symptoms is planned for February 2021. That will be 5 years from the first treatment application at Puketotara. A full report, including tracking of results through time and full statistical analyses, will be provided following this.

It is suggested that these trials are occasionally checked in future years, and that further treatment of trial trees is considered. There should also be consideration of new trials with large trees, evaluating higher doses from the outset. A treatment of one 20-ml injection of 4% phosphite every 20 cm should be included in such trials.

5 Acknowledgements

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6 References

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Re-injection with phosphite, Trounson Park, June 2019.

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