Root rot in radiata pine seedlings can be controlled

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Abstract

Phytophthora root rot is an intractable disease affecting pine seedlings that can cause substantial losses in nursery production. In trials conducted over three seasons at Te Ngae Forest Nursery, Rotorua, foliar sprays with phosphorous acid before root pruning almost completely controlled root rot in radiata pine seedlings. Metalaxyl-M was ineffective when applied at seedling emergence and provided only moderate control when applied at root pruning. Other treatments, including *Trichoderma* spp., humate and lime, and methyl jasmonate were ineffective.

The name 'Phytophthora' literally means plant destroyer and is derived from the Greek words 'phyto' (plant) and 'phthora' (destroyer). There are about 60 species of *Phytophthora*, causing diseases that include root rot, stem canker, leaf blight and fruit rot.

Phytophthora cinnamomi and *Phytophthora cactorum* are widely distributed in New Zealand soils and have been associated with root rot in *Pinus radiata* pine seedlings. Free water is required for dispersal of *Phytophthora* spores and waterlogged soils provide an ideal environment for disease development. The pathogen can infect the roots of healthy seedlings but the risk of infection is increased in plants that are physiologically stressed by flooding or drought, or after root injury. Infected roots and basal stem tissues are severely compromised in their ability to conduct water and nutrients, and so affected seedlings wilt and die (see Figures 1 and 2 next page). Root rot has resulted in losses in seedling production in a number of forest nurseries in New Zealand over the past 30 years. The disease is less problematic in older pines and other plantation conifers (>3 years old) and generally there are no symptoms of ill-health that can be attributed to Phytophthora root rot in mature trees.

Phytophthora is notoriously difficult to control and extreme care should be taken to prevent its introduction into nurseries on contaminated machinery or infected plant material. In areas where the pathogen is already established, it is imperative that cultural (e.g. drainage and good hygiene) and chemical control methods are employed to contain the pathogen and to reduce the risk of infection. Phenylamides such as metalaxyl and metalaxyl-M (e.g. Ridomil® Gold) have been used extensively for control of Phytophthora root rots of a wide range of plants, including conifers. In Australia, salts of phosphorous acid, also referred to as phosphonate or phosphite, have proven effective against P. cinnamomi in radiata pine seedlings and in *Banksia* trees. These compounds exhibit direct antifungal activity and may also stimulate the plant's own defence response to infection (Hardy *et al*. 2001). Phosphorous acid should not be confused with phosphoric acid, which is commonly present in many fertilisers. Indeed, the use of phosphorous acid compounds as sources of plant nutritional phosphorus remains the subject of much debate (Thao & Yamakawa 2009).

A recent series of field trials at Te Ngae Forest Nursery compared a number of treatments, including metalaxyl-M and phosphorous acid, for their ability to control root rot in radiata pine seedlings (Reglinski et al. 2009). A block within the nursery had suffered approximately 30% mortality among 1 million radiata pine seedlings in 2006 despite the application of metalaxyl-M at seedling emergence, and so alternative control options were sought. The first trial (in 2006-07) included a range of 'non-traditional' control options, including seed treatment with *Trichoderma* spp. (beneficial fungi that have proven effective against some diseases), soil amendment with humate to promote beneficial fungi in the root zone, and foliar application of methyl jasmonate to boost plant immunity. An alternative chemical fungicide containing phosphorous acid (Foli-R-Fos® 400), was also included, as this product is registered in New Zealand for the control of Phytophthora root rots in ornamental and nursery stock and in some horticultural crops. Seedlings began to show symptoms of root rot (needles with a dry chlorotic appearance and wilting of the growing tip) in April 2007, approximately one month after root pruning. Disease incidence increased during late autumn and it became evident that metalaxyl and the 'non-traditional' treatments were ineffective, whereas monthly sprays of phosphorous acid provided excellent control.

Subsequent trials over the following two seasons focused on variations in the timing and number of phosphorous acid applications. We also tested metalaxyl applied at the time of root pruning, in March, since our data suggested a causal link between this cultural activity and infection. The results were consistent, and showed that even a single application of phosphorous acid provided almost complete control of root rot in a site where the untreated seedlings became heavily infected. Metalaxyl performed better when applied in March than at emergence in October-November, but was still inferior to phosphorous acid. In 2007-08 we applied Ridomil Gold MZ at both 15 and 50 kg/ha (0.6 and 2.0 kg metalaxyl-M/ha), while in 2008-09 we used Ridomil Gold EC at 4.2 litres/ha (2.0 kg metalaxyl-M/ha). Foli-R-Fos 400 (400 g phosphorous acid/L) was applied at 6.6 L/ha in all trials.

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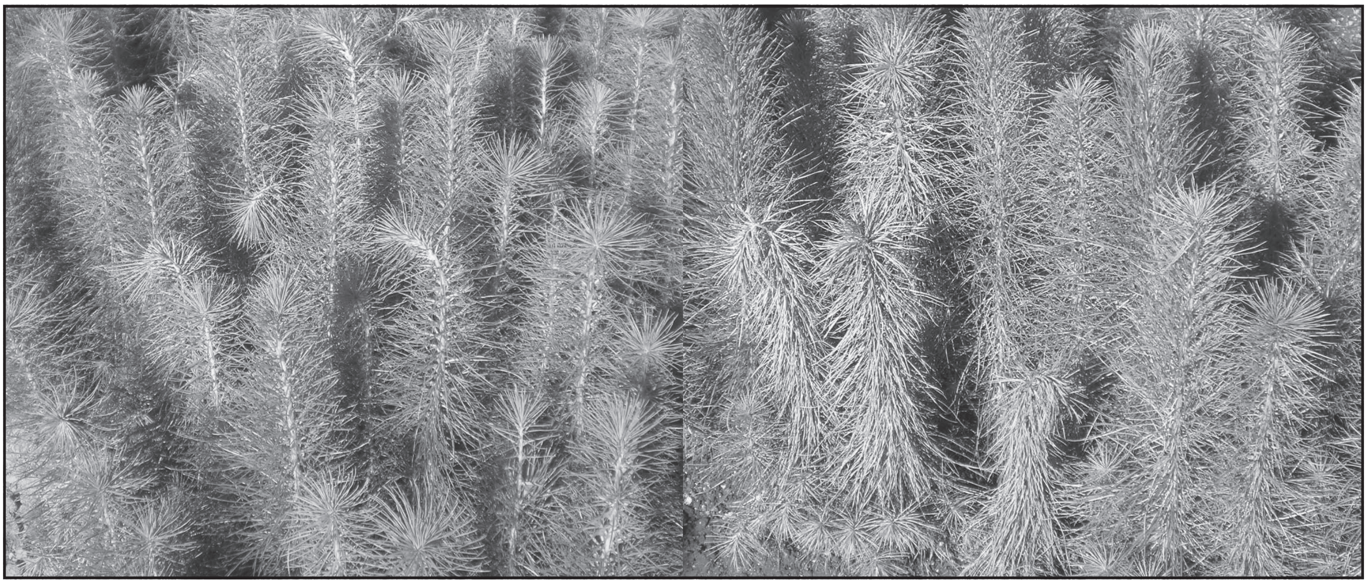

Figure 1. Drooping needles on infected seedlings (a) which fade and eventually turn brown (b).

Figure 2. Discoloured tissue beneath the bark of an infected seedling

Results are shown in the two Figures. 3 and 4 next page.

The poor performance of metalaxyl was disappointing, since it is known to be an effective chemical against *Phytophthora* and recently demonstrated good control of Phytophthora root rot in radiata pine seedlings in our laboratory. Therefore, we sought to determine the persistence of metalaxyl in the trial plots by sampling soil at different times after application. The results showed that the concentration of metalaxyl in the soil at Te Ngae reduced by half to an inactive breakdown product after about 30 days. This may partly explain the inability of this chemical to control root rot in our trials, particularly when applied at emergence. Other studies have shown that the half-life of metalaxyl is strongly influenced by soil type, and can range from 82 days in sandy soil with a pH of 5.8 to less than one day in clay soil with a pH of 3.7 (Monkiedje et al. 2007). Furthermore, the degradation of metalaxyl may be accelerated in sites where it has been used repeatedly, possibly because of a build-up of soil microflora that are capable of degrading the chemical. Indeed, information supplied by the manufacturer of metalaxyl-M (Syngenta Crop Protection) suggests a half-life of 5-30 days in soil and cautions against use of the chemical in areas where it has previously been found to be ineffective.

Phosphorous acid was extremely effective in this study and one single application was able to suppress a notoriously difficult disease in a heavily infested site. Furthermore, it is relatively inexpensive, can be mixed with other spray products and is environmentally benign, so offers many advantages. In our trials, a single application of phosphorous acid suppressed root rot in radiata pine seedlings for at least five months. Similarly, Australian studies have shown that a single foliar application of phosphorous acid protected native species for between five months and two years (Shearer & Fairman 2007). However, there is variation in the longevity of the chemical effectiveness among plant species and against different *Phytophthora* species. Furthermore, while it will protect seedlings from infection by *Phytophthora*, it will not eradicate the pathogen from the soil.

If an outbreak of root rot occurs, the safest approach is to grass the affected area for a few years to reduce the pathogen population and to avoid spreading it to other areas of the nursery. Other cultural practices, such as improving

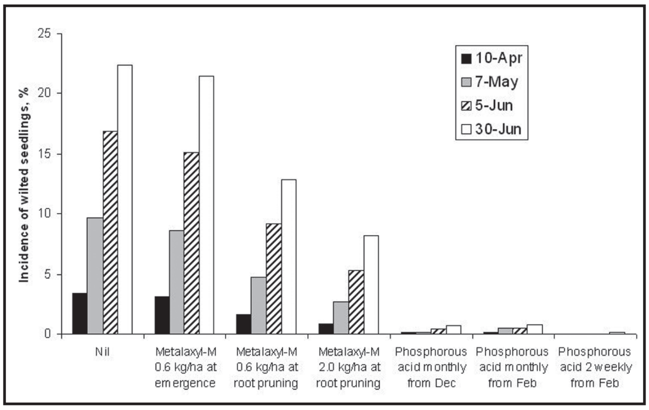

Figure 3. Incidence of root rot in Pinus radiata seedlings assessed on four dates in 2008. Metalaxyl-M (as Ridomil® Gold MZ, 40 g metalaxyl-M/kg) was applied on 1 November 2007 (emergence) or 26 March 2008 (after root pruning). Phosphorous acid was applied as a foliar spray either monthly from 13 December 2007 (6 times), monthly from 13 February 2008 (4 times) or two-weekly from 13 February (7 times).

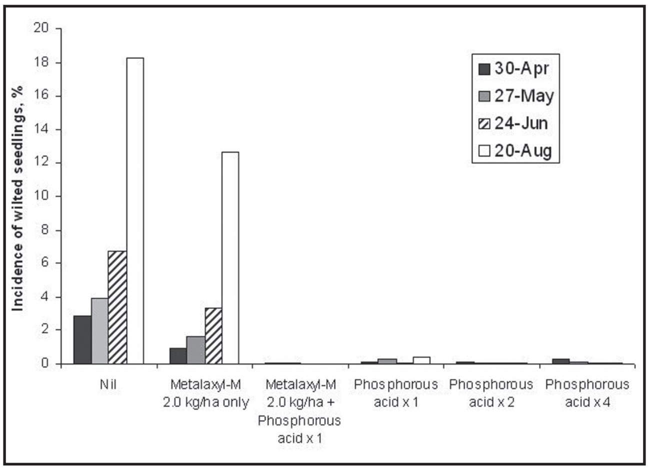

Figure 4. Incidence of root rot in Pinus radiata seedlings assessed on four dates in 2009. Metalaxyl-M (as Ridomil® Gold EC, 480 g metalaxyl-M/L) was applied on 4 March 2009. Phosphorous acid was applied as a foliar spray on 4 March (x1), plus 1 April (x2), 30 April and 27 May (x4).

drainage to avoid flooding and waterlogging, are also advisable to reduce environmental conditions that favour pathogen proliferation. Care must be taken, however, to direct the drainage flow away from vegetation. In addition, rigorous hygiene standards must be followed to prevent the spread of infested soil from affected areas, including washing vehicles, machinery and footwear.

References

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