

## Herbicide persistence in soil following wilding *Pinus contorta* boom-spray operations

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**Summary** Recently the Department of Conservation (DOC) has learnt how to manage closed canopy stands of *Pinus contorta* Douglas ex Loudon using systemic herbicides sprayed with helicopter mounted booms. These large weeds require large volumes of herbicide formulations for effective control. The current best practice formulation includes triclopyr ester, dicamba and picloram at much higher rates than have been applied anywhere in the world. While these levels are permitted in New Zealand, DOC has been proactive in understanding the environmental fate of these herbicides. Soil herbicide residues under experimental plots at two sites in the South Island were tested. Picloram and dicamba were detected at very low levels after 6 months and were undetectable after 12 months. Triclopyr was present in levels harmful to sensitive plants at 6 months and remained detectable in trace amounts after 12 months at one site and 24 months at the second. The levels of residual herbicide detected 12 months after application are unlikely to limit seedling establishment and growth but work is ongoing to test native plant responses to these herbicide residues in the field. These findings suggest that use of high rates of herbicides required for adequate control of *P. contorta* should not prevent colonisation of treated areas by desirable plants for more than 6–12 months.

**Keywords** Wilding pine, *Pinus contorta*, triclopyr, dicamba, picloram.

### INTRODUCTION

There are no species of Pinaceae native to New Zealand, but 10 exotic species are now widely recognised as ‘wilding conifers’ due to their unwanted natural regeneration (Froude 2011). Of these, *P. contorta* is the most prone to spread and is a major environmental weed (Howell 2008) because it displaces native vegetation. A range of control tools exist, but for closed-canopy stands, boom spraying with systemic herbicides is now the favoured technique. The current best-practice formulations have been developed through efficacy trials (Gous *et al.* 2012).

In many places, wilding stands of *P. contorta* occupy sites that supported native forest that was burnt and colonised by grasses and shrubs prior to wilding pine establishment. If these sites can be restored by increasing the abundance of native woody vegetation they should be more resistant to invasion by

shade-intolerant *P. contorta*. This trial investigated the persistence of herbicides in soils after control and the likely effect of these residues on colonisation and growth by native woody seedlings.

### MATERIALS AND METHODS

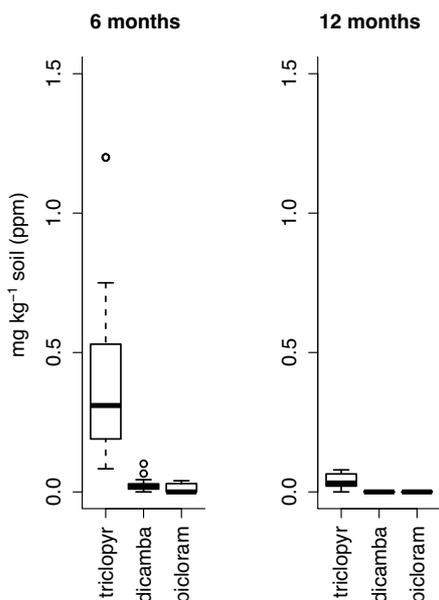
Herbicide formulations containing a base of triclopyr (18 kg a.i. ha<sup>-1</sup>) with dicamba (5 kg a.i. ha<sup>-1</sup>) and/or picloram (2 kg a.i. ha<sup>-1</sup>) were applied at 400 L ha<sup>-1</sup> to large infestations comprising 4–8 m tall *P. contorta* at two sites in the South Island of New Zealand (Jollies Pass and Cattle Flat). Treatments were randomly allocated to 12, 0.5 ha blocks at each site and applied with a buffer of at least 20 metres between blocks in January 2011 (Cattle Flat) and February 2013 (Jollies Pass). Soil samples were collected from all blocks at Jollies Pass in August 2013 and February 2014, 6 and 12 months after application respectively. Soil samples were also collected from 12 treated blocks at Cattle Flat in January 2013, 24 months after application. In all blocks, eight, soil cores (2.5 cm diameter, 10 cm deep) were taken in a ‘Z’ pattern that crossed the entire block. The soil samples from each block were combined and analysed for residual herbicides by R.J. Hill Laboratories Ltd.

### RESULTS

Herbicide residues were only detected within the blocks where they were applied. At Jollies Pass, moderate levels of triclopyr and trace levels of both dicamba and picloram were detected after 6 months (Figure 1). After 12 months, dicamba and picloram were below the detectability threshold of 0.01 mg kg<sup>-1</sup> (ppm) in all plots and all triclopyr residues were less than 0.1 ppm. Differences between the levels of triclopyr detected at 6 and 12 months indicates a mean half-life of 53 days. At Cattle Flat, trace levels of triclopyr were detected 24 months after application and no dicamba or picloram was detected (Figure 2).

### DISCUSSION

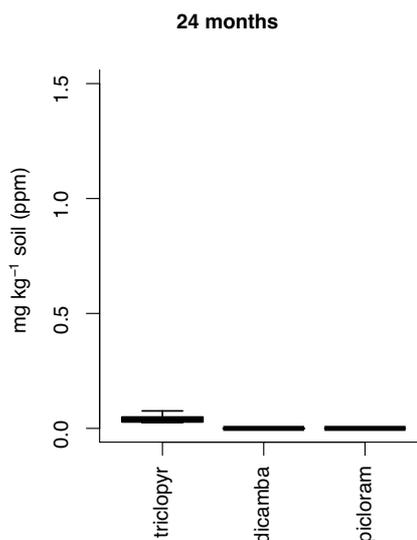
Despite being applied at high rates per hectare, the levels of herbicide active ingredients found as soil residues in this investigation were relatively small. The most persistent active ingredient was triclopyr that was applied at much higher rates than either dicamba or picloram. The half life calculated for triclopyr in



**Figure 1.** Soil residues of three active ingredients detected 6 and 12 months after application at Jollies Pass. Black lines are medians, boxes denote upper and lower quartile ranges, whiskers give the limits of the nominal range of the data and open circles denote outliers.

this study is within the range previously reported for triclopyr in New Zealand soils of 30 to 100 days (Wilcock *et al.* 1991). As the herbicide did not appear to be degrading more rapidly than normal, the low levels detected are probably attributable to only small volumes reaching the soil with the majority intercepted by the large canopy. Using the application rate of 400 L ha<sup>-1</sup>, 40 mL of herbicide is applied per square metre and this appears enough to produce acceptable efficacy (Gous *et al.* 2012) whilst minimising the volume of herbicide reaching the ground.

The likely impacts of trace levels of triclopyr below 0.1 ppm on native species present in this ecosystem are unknown but are likely to be very small given the results of Ranft *et al.* (2010) where equivalent levels in soils caused little damage to mustard (*Brassica juncea* (L.) Czern.) in bioassay trials. The soil residues are also smaller than those detected five months after wandering Jew (*Tradescantia fluminensis* Vell.) control at 3.6 kg triclopyr ha<sup>-1</sup>, where the herbicide was considered almost completely degraded (Standish *et al.* 2002). At the Jollies Pass site, locally-sourced black beech (*Fuscospora solandri* (Hook.f.) Heenan & Smitsen) seed has been recently collected and sown into plots 12 months after formulations were applied, to test for any residual effect.



**Figure 2.** Soil residues of three active ingredients detected 24 months after application at Cattle Flat. Black lines are medians, boxes denote upper and lower quartile ranges, whiskers give maximum and minimum values.

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