Aerial herbicide spraying to control wilding *Pinus contorta* in New Zealand

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Abstract

There is not much information on aerial application of herbicides to control wilding conifers in New Zealand. Two South Island study sites infested with dense *Pinus contorta* were selected to conduct trials testing the efficacy of aerial application of various herbicide combinations. Four herbicide treatments were applied as a randomised complete block of three replications at each site. Herbicides were applied by helicopter during January 2011 using a boom spraying system calibrated to deliver 400 l/ha.

Spray efficacy was determined by measurements of percentage of dead foliage (damage) and mortality 12 months post treatment. Of the four herbicides tested the most effective included 18,000 g triclopyr, 5,000 g dicamba, 2,000 g picloram and 2,300 g ammonium sulphate in an application volume of 400 l/ha. For this treatment tree mortality and damage were respectively 86.6% and 98.6%. Because the systemic herbicides tested here are only effective during the active growing season it is anticipated that mortality may increase in the future.

Keywords: wilding, conifer, aerial, application.

INTRODUCTION

Pinus contorta was introduced to New Zealand around 1880. It is the most vigorous naturally regenerating introduced conifer. The spread of wilding conifers into a wide variety of habitats in New Zealand would result in a significant loss of natural landscape value and biodiversity if the trees were to become fully established throughout their potential distribution ranges. Wilding conifers cover approximately 200,000 hectares of land administered by the Department of Conservation in the South Island. Of this area, approximately two thirds is invaded by *P. contorta* (Ledgard, 2001). The total area increases to over 500 000 ha when private land is included (Gous et al., 2010a, b). Literature contains little information on effective methods for managing these wilding conifers (Ray and Davenhill, 1991; Gous and Raal, 2010). According to Belton and Ledgard (1991), the cost of blanket control of wildings would be high and therefore difficult to justify. In addition, the traditional use of diquat at 15 l/ha in 300 l total volume, does not achieve significant *P. contorta* mortality (4%) after 24 months (Gous and Raal, 2011). This project investigated the use of alternative herbicide treatments and increased application volumes to control dense infestations of *P. contorta*.

MATERIALS AND METHODS

Sites, treatments and application

The two sites selected for this study were located at Ferintosh Station near Twizel and at Cattle Flat Station near Mid Dome, Southland. All herbicides were applied in a total application volume of 400 l/ha. Application was achieved with a MD 520N NOTAR helicopter, at a release height of 10 m above the tree canopy, flying at a ground speed of 30 knots. The aircraft was fitted with 36, D6 – 46 hydraulic nozzles, spaced to 6.4 m from one end to the other, i.e. within 80% of the main rotor width. Measured droplet volume mean diameter (VMD) was approximately 400 µm (Gous and Richardson, 2008).

Treatments (Table 1) were based around triclopyr, a systemic pyridine, foliar herbicide (NZ Novachem Agrichemical Manual, 2010; Wikipedia Foundation Inc., 2012). Each treatment was applied to three plots of approximately 1 ha each. A total of 100 trees were randomly selected and marked for damage assessments. Treatments were applied mid January 2011, during the actively growing period to promote translocation (Radosevich and Bayer, 1979).

Damage assessments

Tree health was recorded as the percentage dead foliage in increments of 10%. Each tree is visually divided into three sections from top to bottom. Each section is scored individually, then averaged for the whole tree score. Assessments were undertaken prior to treatment and at 12 months post treatment. A tree with 100% dead foliage was counted as being dead.

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Table 1 Treatments, herbicides and active ingredients applied to control P. contorta by means of aerial blanket boom application.

Treatment number	Treatment codes	Herbicides	Active ingredients
1	20G10D20T	20ℓ Grazon, 10ℓ Dicamba 500SL, 20ℓ Trichloram Brushkiller, 20ℓ Kwickin oil, 0.5ℓ Companion, 4kg Kondemn	18000 g triclopyr 5000 g dicamba 2000g picloram 2300 g ammonium sulphate
2	20G20T	20ℓ Grazon, 20ℓ Trichloram Brushkiller, 20ℓ Kwickin oil, 4kg Kondemn	18000g triclopyr 2000g picloram 2300g ammonium sulphate
3	30G	30ℓ Grazon, 20ℓ Kwickin oil, 4kg Kondemn	18000 g triclopyr 2300 g ammonium sulphate
4	30G10D	30ℓ Grazon, 10ℓ Dicamba 500SL, 20ℓ Kwickin oil, 0.5ℓ Companion 4kg Kondemn	18000 g triclopyr 5000 g dicamba 2300 g ammonium sulphate

Analysis

All analyses were undertaken using SAS (SAS, 2004). Plot level data was split into the following four height categories, selected so that adequate replication was present within each category : 0 – 5 m; 5 – 7.5 m; 7.5 – 10 m and 10 – 12.5 m. These height classes were assigned values representing the mid-point height of each class so that they could be included in analyses as a meaningful continuous variable.

The analysis tested the effects of replicate, treatment, height class and the interaction between height class and treatment on mortality and damage. Replicate and treatment were included as class level variables while height class was included as a linear continuous covariate. Where the treatment effect was significant multiple comparisons were undertaken between treatments by examining the significance of least square differences using a *t*-test.

RESULTS

Data range

The mean height of trees at the time of treatment was between 6 – 7 m. Across all treatments height ranged from 1.5 – 12.0 m. The height range was similar between treatments 1 and 4 but lower for treatments 2 and 3 (Table 2).

Table 2. Treatment variation in tree height at the time of spray application. Values shown include the mean and range.

Treatment	Mean height	Height range
20G10D20T	6.7	2.0 – 12.0
20G20T	6.5	1.5 – 10.0
30G	6.3	1.5 – 9.0
30G10D	6.8	2.0 – 12.0

Influence of treatment and height class on mortality and damage

Analyses showed treatment to have a strong significant effect on both mortality and damage (Table 3). In contrast, neither height nor the interaction of height and treatment significantly affected either response variable. For both mortality and damage treatments 1 and 4 had significantly higher values than treatment 2, which in turn significantly exceeded values for treatment 3. Mortality and damage were highest in treatment 1 where respective values of 86.6% and 98.6% were recorded (Table 3).

Table 3. Analysis showing the influence of replicate, treatment and tree height class on mortality and damage.

Treatments	Mortality	Damage
20G10D20T	86.6a	98.6a
20G20T	43.0b	90.8b
30G	19.1c	85.3c
30G10D	85.2a	98.5a
General linear model results		
Replicate	3.00ns	4.67*
Treatment (T)	4.89**	5.37**
Ht class (H)	2.04ns	0.21ns
H x T	2.90ns	0.16ns

Shown are the *F* values, followed by the *P* categories. For the *P*-category asterisks **, * denote significance at $P = 0.01$ and 0.05, respectively. Least square means for mortality and damage are shown above the analysis. Means followed by the same letter are not significantly different at $P = 0.05$.

DISCUSSION

There appears to be a synergism between triclopyr and dicamba when used in combination. The two herbicide treatments (treatments 1 and 4, table 1) which contained these active ingredients managed to kill more than 85% of the treated trees after one year. Analyses indicate that tree mortality was independent of tree size for these two herbicides over the rates and tree sizes tested here. The increased coverage obtained by using 400 l/ha, as opposed to 150 l in previous trials, possibly further increased efficacy. This trial will be monitored out to 24 months after treatment. Treatment 1 was operationally implemented during the summer of 2011/2012 (P. Willemse, DOC, Twizel, 2011, pers. comm.).

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