EFFECT OF SOME COMMON WEED SPECIES ON *PINUS RADIATA* GROWTH AT A DRY SOUTH ISLAND SITE

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ABSTRACT

Reductions in radiata pine (*Pinus radiata* D.Don) growth caused by a range of common weed species were measured at a site where water availability was known to limit tree growth. Radiata pine seedlings were grown for 3 years on their own or with volunteer herbaceous broadleaves, broom, gorse or browntop. Water and nutrient levels were varied by factorial +/- irrigation and fertiliser treatments. Radiata pine stem volume was reduced in the presence of all four weed types. Herbaceous broadleaf weeds had the greatest effect on tree growth, gorse had the smallest effect, and broom and grass were intermediate. Water supply was thought to have a major effect in determining the influence of weeds on tree growth.

Keywords: competition, radiata pine, weeds, water potential

INTRODUCTION

Due to increasing costs and pressure to minimise herbicide use, it is essential that weed control operations in radiata pine plantations should be applied only at the level required to give optimal gains. Priority should also be given to targeting species that have the greatest impact on crop growth. These objectives can best be achieved by understanding the nature of the interaction between the crop and the weeds, and how this varies over different sites and climates. To this end, a study was designed to investigate the effect on early tree growth of some prominent New Zealand forest weed species.

METHODS

A trial was installed at Rangiora, Canterbury, on a site with a mean annual rainfall of 702 mm, a mean annual temperature of 11.4°C, and an annual average raised pan evaporation of 1329 mm (based on Christchurch airport data) (NZMS 1981). The soil was a heavy Wakanui silt loam with high nutritional status but low organic content.

The experiment, which has been described in detail by Richardson *et al*. (1993), consisted of a complete factorial set of treatments laid out in four blocks using a split plot design. There were three treatment factors - weed type, fertiliser and irrigation. The five weed types were: gorse (*Ulex europaeus* L); broom (*Cytisus scoparius* L); browntop (*Agrostis tenuis* Sibth.); herbaceous broadleaves (volunteer species); and weed-free. Fertiliser (broadcast macro- and micro-nutrients) and irrigation were applied at two levels (nil; fertiliser/water applied). The experimental blocks were split into halves, one half of each being irrigated once per week, for a period of 3-5 hours during summer months. No record was kept of the amount of water supplied. Within each irrigated plot, fertiliser and weed type treatment combinations were completely randomised within subplots.

Radiata pine seedlings (GF 17, 1/0) were planted in July 1990 at 1 x 1 m spacing, giving 25 trees per 5 x 5 m subplot, with only the inner 9 trees used for measurements. Seed of broom, gorse and browntop was broadcast-sown, broom and gorse in the autumn prior to planting, and the grass during the following spring. Herbaceous broadleaves were allowed to emerge and grow. Unwanted weeds, including grasses from herbaceous broadleaf plots and vice-versa, were periodically killed with a combination of hoeing, hand weeding, and application of herbicides.

Tree height and ground-level stem diameter, and weed height and percentage cover were measured in Winter 1995 and Winter 1996. Radiata pine fascicle water potential

* Since deceased

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was measured using a pressure bomb on several days during dry periods in mid-late summer of the second and third years. Water potential measurements were taken from both irrigated and unirrigated treatments. In Year 2, they were confined to weed-free, grass, and broom subplots treated with fertiliser, but in Year 3 all fertilised subplots were measured.

Effects of treatments on tree height, diameter and volume (calculated as $\pi/4$ x root collar diameter^2) and water potential were assessed using analysis of variance, after a natural logarithm transformation to stabilise the variance where appropriate. Initial tree size (height and diameter) was tested as a covariate in the analysis of tree growth. Time of measurement and time squared were used as covariates in the analysis of fascicle water potential data.

RESULTS

Annual rainfall was 26, 157 and 36 mm below average and annual mean temperatures were 0.9, 0.4, and 1.1°C warmer than average during the three years of the trial.

Browntop and herbaceous broadleaf species rapidly covered 100% of the subplot area. Predominant broadleaves were *Rumex* spp., particularly sorrel (*R. acetosella* L.) and catsear *(Hypochaeris radicata* L.). Growth of broom and gorse was slower and their distribution was less even. By April 1991, the average ground cover for both species was approximately 40%. By the end of summer of the second year, ground cover in all treatments was approaching 100%; the broom was almost as tall as the pine, and the gorse was about 75% of *P. radiata* height. At the end of the third year, both broom and gorse were both about the same height as the pine.

Three years after planting, tree height, diameter, and volume were all significantly influenced by weed type ($P < 0.0001$) (Fig. 1). Effects on height growth were less pronounced than those on stem diameter or volume. In the case of volume (the best overall indicator of treatment effects on tree growth), no significant effect of fertiliser application ($P = 0.06$) and no interaction between weed type and fertiliser ($P = 0.21$) was detected. This suggested that nutrients were non-limiting at this site. Irrigation had no overall influence on volume ($P = 0.67$), but there was significant interaction between irrigation and weed type ($P = 0.001$). With the most competitive weed type, herbaceous broadleaves, there was a 103% volume increase with irrigation. Tree growth with all other weed types except grass (17% volume increase) decreased slightly following irrigation. There was no clear effect of irrigation on weed height or percentage cover.

Although fascicle water potential was not affected by irrigation in years 2 or 3 ($P = 0.15$ and 0.13, respectively), an effect attributable to weed type was noted ($P = 0.02$ and 0.01). In Year 2, the water potential of fascicles from trees growing with broom (- 2.08 MPa) was lower than that of trees in the grass and weed-free treatments (mean of -1.47 MPa). In year 3, the fascicle water potential of trees growing in the broom, no-weeds, or gorse weed types (average of -1.22 Mpa) was lower than those growing with herbaceous broadleaves and grass (-1.094 and -0.945 MPa respectively).

DISCUSSION

Although resident herbaceous broadleaves caused the greatest reduction in tree growth over the three years of this experiment, the influence of broom and gorse was observed to increase over time. Of all the weeds, gorse has the smallest effect and was in fact, the slower growing of the two shrub species.

Low soil water availability and high leaf-to-air vapour pressure differences during the summer months are factors known to limit tree growth in Canterbury (Balneaves 1982; Clinton and Mead 1990). The infrequent irrigation applied in the trial provided insufficient water for an overall improvement in tree growth. Irrigation modified the negative effect of herbaceous broadleaves on tree growth, and this implies that sufficient water had been applied to provide some alleviation of water stress in this treatment. The lack of response of weed-free trees to irrigation suggests that water was not limiting growth when weeds were not present.

Variations in the development of water stress in pines growing with differing herbaceous species is probably a result of water usage patterns related to physiological

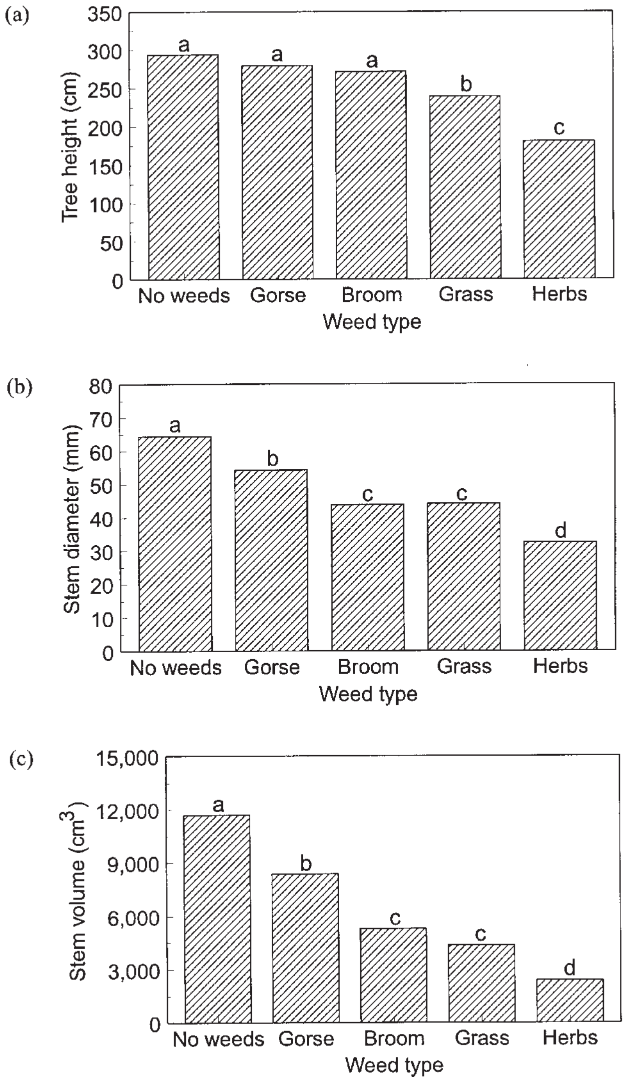

FIGURE 1: Effect of weeds on radiata pine (a) height, (b) diameter, and (c) stem volume, averaged over all fertiliser and irrigation treatments, 3 years after planting. Bars topped by the same letter are not significantly different at the 5% level according to Fisher's Protected LSD test.

characteristics and plant growth habit including type and depth of root system (Flinn *et al.* 1979; Jackson *et al.* 1983; Nambiar and Zed 1980; Sands and Nambiar 1984). In this experiment, where water was probably the most critical factor, herbaceous broadleaves had a greater negative effect on tree growth than browntop. In summer of Year 2, fascicle water potential was lower in trees growing with herbaceous broadleaves than in those growing with grass. No significant difference was noted in Year 3. Australian research has shown that radiata pine in grass plots were less severely stressed for water than trees in plots containing sorrel because of grass dieback during summer (Nambiar and Zed 1980). Grass dieback was observed during each summer at Rangiora and may have contributed to the different effects of these weed types on pine growth. By Year 3, trees growing with herbaceous plants (i.e. grasses and broadleaves) had a higher fascicle water potential than those in any of the other three treatments. This may reflect tree root extension beyond the rooting zone of herbaceous species (Sands and Nambiar 1984). Total tree needle area in the no-weeds, gorse and broom subplots would have been much higher than in the herbaceous weed type treatments, because of better growth in previous years; this would have led to a higher tree demand for water.

In dry areas such as the trial site, where water is an important factor influencing tree growth, vegetation management must allow for below-ground interactions between trees and weeds. Weed control should be maintained until tree roots gain free access to water (probably at least two years). Weed control of herbaceous species should be given priority, although shrub species are likely to become more competitive over time. The variable effects of different herbaceous plants on tree growth should be taken into account during consideration of oversowing on dry sites. A critical issue from the manager's perspective, which requires further research, is the definition of sites where tree moisture stress is unlikely to be intensified by the presence of other plants.

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