Establishment of mountain beech in high country grassland

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Abstract

We report the results of a trial comparing the establishment of mountain beech planted in dense browntop-dominated grassland in the presence and absence of herbicide. At age five survival was increased from only 8% in the absence of herbicide to 24% where herbicide was applied. Plant survival was strongly influenced by the root collar diameter of planting stock. Except on sites prone to winter dessication, well-grown stock used in conjunction with herbicide to control competition should ensure good survival in most seasons, even in competitive grassland environments.

Introduction

The retirement of South Island high country grasslands from grazing under the Crown Pastoral Land Act Land Tenure Review process will lead to increased spread of exotic woody weed species, as grazing management practices maintaining the grasslands are removed. In areas where the land was previously forested, it may be appropriate to attempt to re-establish an indigenous forest cover to reduce its vulnerability to invasion by woody weed species.

Forest remnants and subfossil remains show that mountain beech (*Nothofagus solandri* var. *cliffortioides*) forest would have been one of the major associations to occur in the region prior to its removal by fire (Molloy 1969). Mountain beech forest regenerates mainly by slow marginal spread from remnant patches, though rare instances of long distance spread into manuka shrubland have been recorded (Burrows & Lord 1993). The inability of mountain beech to spread rapidly and recolonise grassland environments it once occupied contrasts markedly with that of exotic conifer species, especially pines (Hunter & Douglas 1984; Ledgard 2001). Intervention will be needed to ensure re-colonisation by mountain beech to areas it occupied before its destruction.

We have recently shown it is possible to re-establish mountain beech by seeding immediately after beech forest destruction by fire (Ledgard & Davis 2004). Seeding beech in combination with pasture species failed completely, however, indicating that establishment by seeding in grassland is unlikely to be successful. We found no other accounts of attempts to establish the species by seeding in grassland. Planting of mountain beech in high country grassland environments has often resulted in poor establishment. Ledgard & Baker (1988) summarised results of a series of informal trial plantings carried out over a number of years in the Craigieburn Range, Canterbury, and stated that although many thousands of seedlings had been planted over the years, relatively few had survived more than one or two seasons.

None of these trials, however, examined the use of herbicide to reduce competition from herbaceous species, a practice almost universally used in the establishment of exotic conifer species. Wardle (1984) noted high (> 90%) first-year survival of black beech (*N. solandri*) planted in herbicide treated grassland in Canterbury foothills, though many plants were subsequently killed by winter dessication. Here we report the results of a trial comparing the establishment of mountain beech planted in high country grassland in the presence and absence of herbicide.

Methods

The trial site chosen was at 620 m elevation on a south-east-facing lower-slope (11°) of Mt. Barker in the Rakaia catchment, Canterbury (grid reference NZMS K35 964602). The grassland was a dense sward dominated by browntop (*Agrostis capillaris*), hard tussock (*Festuca novae zelandiae*) and matagouri (*Discaria toumatou*). The Tekapo soil is derived from a 35cm (range 22–65cm) thick layer of loess over greywacke moraine till. The A horizon thickness averaged 24 cm (range 20–27cm). Annual precipitation at Lake Coleridge homestead (520 m, 1.5 km distant) is 907 mm.

The plot area was fenced to exclude rabbits and hares and planting locations were marked at 2m intervals along rows spaced 2m apart. There were 10 rows with 10 plants in each row. Alternate locations along each row were pre-plant sprayed, about one month before planting, with a mixture of 'Gardoprim' (60 ml/litre) and 'Gallant' (6 ml/litre) herbicides. Sprayed spots were about 1m in diameter. Mountain beech plants were collected as 10–20 cm high seedlings from the Craigieburn Range (and so assumed to be mycorrhizal) and raised for two years under nursery conditions.

Plant heights (mean 28 cm, range 18–46 cm) and root collar diameters (mean 3.8 mm, range 2.0–6.8 mm) were measured after planting in

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Fig. 1: Survival of mountain beech up to 5 years in the presence and absence of spot spraying with herbicide. November to February rainfall is shown along the top, and climatic factors likely to have contributed to mortality are shown. Bars show standard errors.

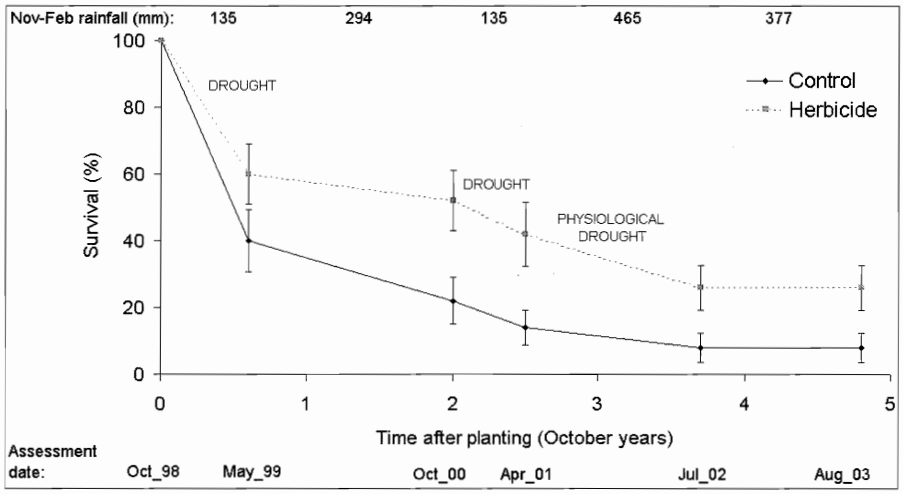


Fig. 2: Cumulative height growth of mountain beech with and without spot-spraying with herbicide. Bars show standard errors.

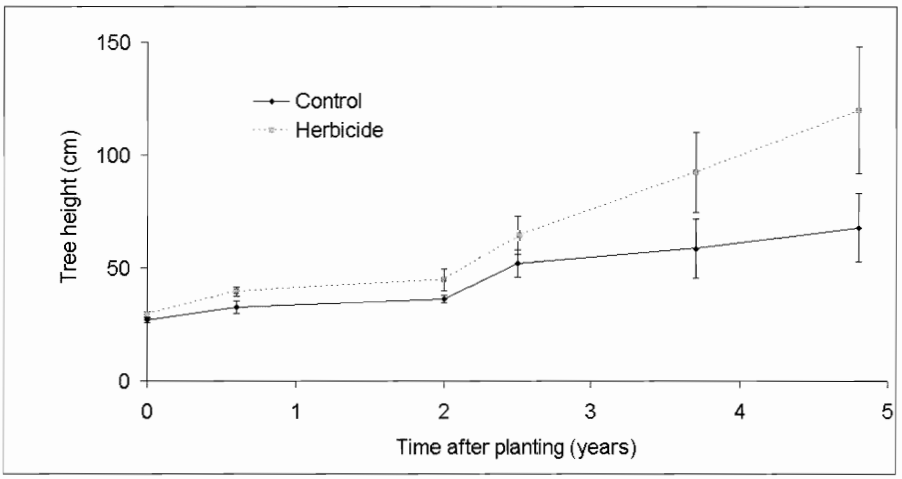
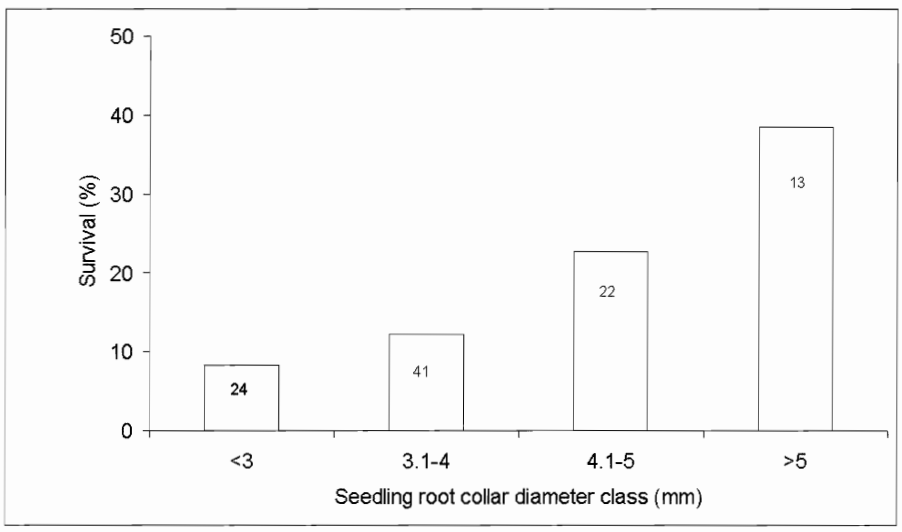


Fig. 3: Influence of seedling root collar diameter at planting on survival of mountain beech. Values in histograms show the number of seedlings in diameter classes at planting.



October 1998. A follow-up herbicide application to control regrowth of herbaceous vegetation, around previously sprayed seedlings only, was made in November 2000 using 'Roundup' (10 ml/litre).

Results and Discussion

Herbicide application increased plant survival, nearly 5 years after planting, from 8% without herbicide to 24% where herbicide was applied (Fig. 1). Herbicide nearly doubled plant height growth after five years, from 68 cm without herbicide to 120 cm with herbicide (Fig. 2). Survival declined progressively during the first four years, but no further mortality occurred after the fourth year.

The coincidence of a number of extreme climatic events during the trial period may have contributed to the low overall survival. Dry summers occurred during the first and third growing seasons after planting. In those years 135 mm of rain fell during the summer months of November to February inclusive, which amounted to 50% of normal rainfall for this period. Drought periods of this intensity have occurred at the Lake Coleridge homestead site only on two other occasions since records began in 1914. The dry summer during the establishment year resulted in particularly high mortality (60% and 40% in the control and herbicide treatments respectively) and the difference in survival between treatments was established during that season. Mortality during the drought of the third summer, while lower, amounted to 36% and 19% in control and herbicide treatments respectively, of plants that were alive at the beginning of the third growing season. Rainfall for the summer months for the second, fourth and fifth growing seasons was above normal, but substantial mortality occurred in control plants in the second season.

Substantial mortality (43% in

both control and treated plants) was also recorded at the end of the fourth growing season (July 2002), possibly as a result of winter dessication occurring during the previous winter. Winter dessication (sometimes called frost drought or physiological drought), occurs when water uptake is inhibited by soil freezing (Kimmins 1987), and may often cause mortality of beech seedlings establishing in the open away from a forest stand (Wardle 1984). The month of July of 2001 began with two weeks of exceptionally cold, frosty, but unusually sunny weather over much of the South Island, with inland areas being subject to an extended period of severe frosts (NIWA 2001). One of us (GB) observed soil freezing to depths of 30 cm on south facing slopes in the Canterbury high country, with the ground remaining frozen for 3-4 weeks. Early spring dieback of new Douglas fir plantings on south facing slopes in the region appeared to be linked to these climatic conditions.

Plant survival was strongly influenced by the root collar diameter of planting stock (Fig. 3). Only 8% of plants with an initial root collar diameter of less than 3 mm survived to age five, whereas 38% of plants with a root collar diameter of more than 5 mm survived. Plants of the largest diameter class ranged from 5.2–6.8 mm in root collar diameter. There were insufficient seedlings in the higher root collar diameter classes to test whether there was a positive interaction between root collar diameter and herbicide application.

Conclusions

For high country plantings of mountain beech Ledgard & Baker (1988) recommend 3-year-old stock with a minimum root collar diameter of 6 mm and height of 60 cm be used. Although our stock was only 2-year-old and half the height of that recommended, the present results confirm that well-grown stock is a key to successful establishment and indicate that root collar diameter may be the important indicator to measure. Except on sites prone to winter dessication, well-grown stock used in conjunction with herbicide to control competition should ensure good survivals in most seasons, even in competitive grassland environments.

Acknowledgement

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References

Burrows, C.J.; Lord, J. M.1993: Recent colonisation by *Nothofagus fusca* at Cass, Canterbury. *New Zealand Journal of Botany* 31: 139-146.

Hunter G. G.; Douglas M. H. 1984: Spread of exotic conifers on South Island rangelands. *New Zealand Journal of Forestry* 29: 78-96.

Kimmins, J. P. 1987: "Forest Ecology". Macmillan, New York. 531 p.

Ledgard, N. J. 2001: The spread of lodgepole pin (*Pinus contorta*, Dougl.) in New Zealand. *Forest Ecology and Management* 141: 43-57.

Ledgard, N.J.; Baker G.C. 1988: Mountainland forestry. *Forest Research Institute Bulletin* 145, Forest Research Institute, New Zealand.

Ledgard, N.J.; Davis, M.R. 2004: Restoration of mountain beech (*Nothofagus solandri* var. cliffortioides) forest after fire. *New Zealand Journal of Ecology* 28 (1) (in press).

Molloy, B.P.J. 1969: Recent history of the vegetation. In G.A. Knox (Ed.) The natural history of Canterbury. A.H & A.W. Reed, Wellington.

NIWA 2001: New Zealand climate digest. National Institute of Water and Atmospheric Research Ltd., July 2001.

Wardle J. A. 1984: "The New Zealand beeches – ecology, utilisation and management". New Zealand Forest Service, Wellington.

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