

A promising new species option for inland South Island sites – hybrids of *Pinus attenuata* with *Pinus radiata*

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Large areas of land in the high country of central South Island are becoming progressively less economic for farming. In this region, however, there are many sites with a forestry potential. Such sites often have good rainfall which, together with very high insolation, can make them highly productive (Ledgard and Belton, 1985). While the demand for such land for afforestation is currently very problematic, it is prudent to know and compare species options.

Choice of species for such sites, where the climate is semi-continental, has become increasingly problematic because invasiveness has become an important consideration in addition to adaptability, growth, form and wood value.

In respect of adaptability, *Pinus radiata* is a high-risk proposition. While it can be very productive, despite very modest site indices, it is vulnerable to climatic damage from frost, drought or snowfall. Frost and drought are troublesome, but not usually insuperable. Heavy snowfalls remain the biggest climatic risk, which is generally seen as unacceptable for plantations. Several conifer species are available which are much better adapted to such sites than *P. radiata*. These include *P. contorta*, Corsican and ponderosa pines, Douglas fir and European larch.

Among them, Douglas fir can be the best performer, but it is very vulnerable to frost damage on flat ground. Larch would be the least productive, and is liable to severe lean and crookedness unless growing in very sheltered situations.

The hybrid

In recent years, however, invasiveness has come to the fore as a strong objection to using these better-adapted species. Among them, ponderosa pine would rate as the least invasive, but it is also the least attractive on the scores of rotation age and most wood properties.

Outside this list of alternatives to *P. radiata*, its hybrid with the knobcone pine, *P. attenuata*, has been of some interest for many years (Dungey et al, 2011). This hybrid combination occurs on a very limited scale in nature, it was readily produced in the 1930s at the Placerville Arboretum in California (Critchfield, 1967), and it has occurred spontaneously in the South Island.

The interest lay in the hope of effectively extending the climatic range of *P. radiata*, mainly in terms of frost and drought resistance. From 1961, hybrids were tested in New Zealand, along with the parent species. The largest trial was on a frosty site on

the Kaingaroa Plateau, and the hybrids initially looked very promising. However, by the mid-1960s it became clear that *P. attenuata* and the hybrids were unsuitable wherever *Dothistroma* needle blight could be a factor.

Field trials

Trials in central South Island sites were begun in 1961 (Dungey et al, 2011), when hybrids and *P. radiata* were included in a provenance trial of *P. attenuata* at Naseby in Central Otago 640 metres above sea level. In 1978, small trials involving hybrids were planted at Craigieburn inland Canterbury 850 to 880 metres above sea level, and Molesworth inland Marlborough, 1000 metres above sea level.

The evidence from the early individual trials was generally sketchy, but it pointed cumulatively to the hybrids being better suited than *P. radiata* and other pines on harsh sites in central South Island. This was on the basis of survival, growth and form. One exception was relatively high mortality, probably due to root rot, in a hybrid seedlot on a stabilised scree slope at Craigieburn.

Among *P. attenuata* provenances, those from the north of its range in southern Oregon were deemed the most promising for hybridising with *P. radiata*. They were of much the best form and were likely to be the hardest.

The photograph on the next page shows Ribbonwood Station hybrid trial age 13 years, with a Douglas fir thinning and pruning trial behind. There are 36-tree blocks of each species. The *P. attenuata* trees are smaller and paler with open crowns, the pure *P. radiata* is dark green with bushy foliage obscuring malformed stems, and the hybrids are intermediate in colour and are the largest.

In front, on the right behind a few Douglas firs, is a block of the hybrid, to the left of that in front, pure *P. attenuata*, with the hybrid further left again. A block of *P. radiata* is immediately behind the *P. attenuate*.

More systematic approach

The results from these early trials maintained sufficient interest in hybrids to prompt a more systematic approach to producing and testing hybrids. As a result, a crossing programme involving 15 parent clones each of *P. attenuata* and *P. radiata* was completed in 1994.

Replicated field trials were established in 1998 in



The photograph shows Ribbonwood Station hybrid trial age 13 years, with a Douglas fir thinning and pruning trial behind.

Canterbury at Ribbonwood Station 700 metres above sea level and Balmoral Station 730 metres above sea level in the MacKenzie Country, and at Eyrewell 160 metres above sea level on the Canterbury Plains, with a subsidiary trial at Mt Barker 600 metres above sea level near Lake Coleridge.

A year four assessment showed that at Ribbonwood and Balmoral, hybrids and *P. attenuata* had much better survival than *P. radiata*, while the hybrids had the greatest height growth and *P. attenuata* the least. At Eyrewell, however, no real superiority was evident for the hybrids.

Age eight assessment and results

The year 2006 brought an exceptional snowfall, which led to dramatic differences in snow damage and in subsequent tree form. Results of a follow-up assessment are summarised in the table. Note that a figure of zero for snow resistance would mean that the material was totally flattened. In fact, *P. radiata* suffered severe damage, especially at Ribbonwood and Balmoral, *P. attenuata* almost none, and the hybrids very little.

Summary results of age-8 assessments of trials planted in 1998, showing relative performance figures and observed absolute mean of best taxon, for each trait at each site. Different suffix letters denote significant differences between taxa.

Taxon	Survival	Height	Acceptability	Snow resistance
Ribbonwood 700 metres above sea level, Latitude 44°				
Hybrid	92	100 a	100 a	94 a
Attenuata	100	67 c	59 b	100 a
Radiata	18	76 b	20 c	51 b
Mean – percentage of best taxon	92%	6.93 m	56%	4.95 (0–5)
Balmoral Station 730 metres above sea level, Latitude 44°				
Hybrid	90	100 a	100 a	94 a
Attenuata	100	70 c	87 a	100 a
Radiata	29	83 b	20 b	70 b
Mean – percentage of best taxon	91%	5.51 m	55%	4.99 (0–5)
Eyrewell 160 metres above sea level, Latitude 43°				
Hybrid	100	83 b	100 a	100 a
Attenuata	83	53 c	69 b	100 a
Radiata	88	100 a	84 b	85 b
Mean – percentage of best taxon	94%	10.01 m	75%	4.93 (0–5)

For survival, growth and stem acceptability the hybrids were generally the best, or nearly so, except for growth at Eyrewell.

Discussion

Our results have shown the hybrids to be superior overall for the harsh, inland South Island sites. This corroborates an anecdotal observation by one of us, who had earlier seen the hybrids and both the parental species growing in adjacent blocks in the northern Sierra Nevada, California. The level of snow damage was a 'night-and-day' comparison between *P. radiata*, and *P. attenuata* and hybrids.

The hybrid combination is considered unlikely to be invasive, although firm conclusions await further evidence. The cones of *P. attenuata* are extremely serotinous, generally requiring a fire to open them, and cones of the hybrids can be expected to open much less readily than those of *P. radiata*. In addition, the seeds are much heavier than those of the species which are known to be highly invasive, and even if released should not be blown nearly so far.

Commercial use of hybrids will require some system of mass propagation. Producing enough known hybrid seed for routine seedling stock will almost certainly be too difficult or costly, so some means of vegetative multiplication of hybrids is indicated. Mass multiplication of nursery cuttings has yet to be proved with the hybrid, but it should be feasible although with less margin for error than with pure *P. radiata*. However, more challenging multiplication technologies, involving in-vitro culture and including cryo-preservation, have been developed with the hybrid (Hargreaves et al 2008).

In the balance, the hybrid may well be the best commercial option for a large area of land where a combination of harsh climatic conditions and concerns over invasiveness severely restricts the species options. However, a further option which has not been explored for such sites is the northernmost population of the closely related *P. muricata*.

References

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NZIF 2013 Conference New Plymouth 30 June to 3 July

Our 2013 conference will explore how one region attempts to balance the drive for economic development against the ever increasing demands for environmental and landscape protection and enhancement which ensures a sustainable pathway for future generations. Collaborative efforts, which enhance vegetation and forest cover in an intensive dairying environment, will be showcased.

The formation of the Taranaki Riparian Management Programme has provided a foundation for cooperation between diverse land use interests. How this has been achieved and its successes to date will be a core component of the conference.

Delegates will hear about the mechanisms used in a practical way to implement national environmental policies at the regional level. Included will be presentations on the role of farm plans and their voluntary implementation of protection and riparian creation works to mitigate the pollution caused by modern intensive farming practices.

Department of Conservation representatives will provide an overview of how the Department is implementing its national objectives, values and plans at a provincial level and its natural heritage prioritisation system as it relates to Taranaki. Practical presentations including pest control initiatives. Also incorporated in the conference programme are voluntary community based projects to create and protect inland sanctuaries to enhance the habitat of native flora and fauna.

The conference will be rounded out on the second day with presentations on current approaches of commercial forestry interests to the sustainable management of plantation resources while recognising ever increasing demands of non-forestry interests. Papers will be presented on

- The industry's long term vision for environmental research in production forests
- The continuing search for alternative production species
- New forest investment opportunities with carbon, permanent sinks and other mechanisms with application in the Taranaki hinterland

The role of trees means that foresters have an important role to play in the transformation of our landscapes to ensure the values of indigenous plants and animals can harmoniously exist with the goals of economic development.

This conference is a regional case study which highlights the successes and acknowledges the failures of previous land use decision making. Hopefully it will provide delegates with ideas and approaches which may be relevant back on their home patches.

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