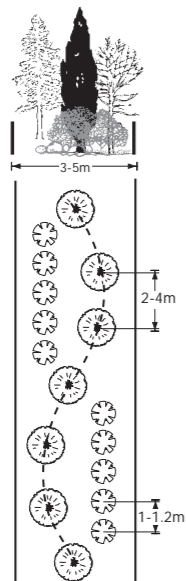


Selection of species and design is always related to site conditions. As an example, the adjacent design using Poplar or Alder with a shrubby native understory may be appropriate to a site with heavier soils and a high water table or irrigation and where the land owner might specify 'minimal shading effect' and 'reduced land loss'.

Spacing of the trees is dependent on the angle of the eroding wind - 2m if the site is directly across the Nor/Wester and up to 4m if the wind is at 45°. Spacing determines the level of wind 'filtering'.

The native plants will provide good stock shelter and should be planted at 1-1.2m spacing. Suitable species include NZ flax, Black matipo and Broadleaf.

Shelter designs are available from Customer Services staff at Environment Canterbury.



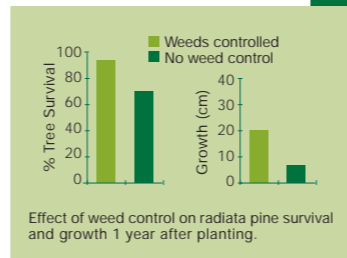
Site preparation

Cultivation, with a winged ripper, encourages root growth to exploit deeper sources of moisture and nutrients, and will aid stability. Dry soil conditions are required to obtain a good shatter zone.

Single tyne ripping promotes 'root run' and is not recommended unless 3 rips (approximately 30cm apart) are made.

Weed control

Good weed control is essential for high seedling survival and uniform growth. Weed control may be achieved chemically (pre/post plant spraying) or manually with a grubber. A 1 m² weed free "spot" is required for each plant.



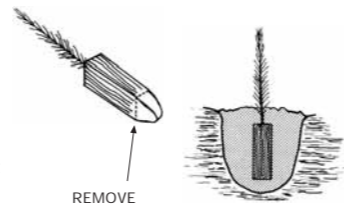
Newly planted seedling growing in a 1m² pre-plant sprayed "spot". The surrounding unsprayed growth protects the young tree from wind during the first, critical year.

Planting

As it is important that 100% survival be achieved planting should be thorough rather than rushed.

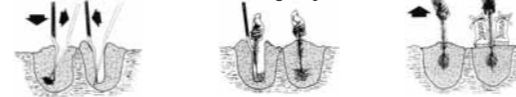
Root-trainers

Open root-trainer, taking care not to disturb the soil block. Remove 2-4 cm at base of soil block with a sharp knife or shears. Plant in well-cultivated ground, covering soil block.



Bare-rooted trees

A 30 cm x 30 cm area should be cultivated to a spade depth (after scraping off and discarding, the surface 1 cm of soil if a residual chemical had been applied) and the seedling inserted. After returning the soil to the planting hole the young plant is lifted 1-2 cm to ensure the roots are pointing downwards and the cultivated area is gently firmed.



Open hole in well cultivated soil Place seedling and fill Pull up and firm

Seedlings are usually planted to nursery depth but drought-prone or sites with light soils may have up to 1/3 of the stem planted.

Maintenance

Replacements:

100% stocking is necessary for efficient shelter. Mortalities should be replaced during the following planting season.

Releasing:

Follow-up attention to weed regrowth may be required. Tree vigour and survival is improved if weed-free 'spots' are retained for several years after establishment.

Management:

Regular pruning of the lee (faster growing) row of trees maintains aerodynamic permeability and greatly improves stability.

Landscape

Wherever possible windbreaks should be sited to run with the lines of the land - the swales, terraces, valleys etc.

Shelter belts should not suddenly stop and start - plantings should link with other plantings such as copses or woodlots.

Remnant native areas should be valued and extended. The use of local native flora may be incorporated into shelter designs on some sites.

This pamphlet has been produced by Environment Canterbury to promote sustainable land management practices. For further information please contact Customer Services, Christchurch, ph: 03 365 3828, freephone 0800 EC INFO (0800 32 4636)

Printed on environmentally friendly paper: 50% recycled fibre (35% pre-consumer, 15% post consumer), 50% ECF (elementally chlorine free) fibre. All virgin fibre used comes from sustainably managed forests. E04/71 January 05.

Project diary

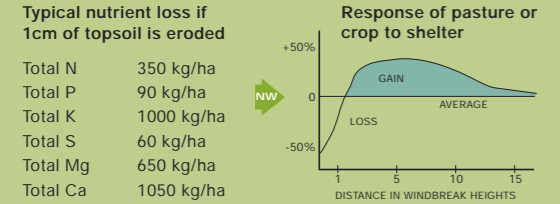
Note - plants should be ordered in the year prior to planting season	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Cultivation / ripping												
Fencing												
Pre plant weed control												
Planting												
Watering												
Post plant weed control												
Mortality count												
Order replacements												

Establishing shelter for soil conservation in Canterbury



This pamphlet outlines the principles of shelter and the techniques of establishing windbreaks as a sustainable land management practice.

- Shelter reduces windspeed and the risk of erosion.
- Shelter reduces stress on stock and crops, improves irrigation efficiency and can provide a future timber source.



1cm soil loss = 100 tonnes per ha.

Control of wind erosion is most effective when the establishment of shelter is undertaken in tandem with other sustainable land use practices such as minimum tillage and stubble mulching.

Planning

Four factors need to be considered when planning the establishment of shelter:

- Orientation:** Windbreaks are most effective when sited at a right angle to the eroding wind.
- Permeability:** To avoid causing damaging turbulence it is important that shelter filters the wind. This is achieved by planting at pre-determined spacings (e.g. 3 m in a 2 row design) and pruning. A 50% porosity is optimum. Research shows that where wind velocity is halved the eroding energy is reduced by approximately $1/8$.
- Length:** The longer the windbreak the better the protection. Short (eg <200m) plantings have a disproportionate 'edge' effect where wind slips around the ends reducing the area of protection.
- Height:** Tall (>30 m) shelter gives the most economic protection as the area protected is directly related to the height of the windbreak. Protection from wind extends for a distance 10-15 x tree height.

Design

2 row shelter designs offer advantages over single row planting.

Stability: The anchoring effect of the NW row reduces root plate rocking of the adjacent faster growing row.

Rotation: Having a slower growing/longer living species row in tandem with a quicker growing/shorter rotation line offers the best of both worlds. The faster trees give early shelter and may be felled at, say, age 30 for timber and roundwood. The remaining line, after management, (eg pruning alternate stems to $1/2$ height for permeability) will continue to provide good erosion control protection for many years.



2 row Conifer Design



NW Row:
Himalayan Cedar



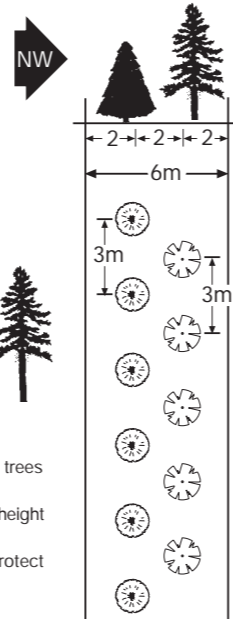
Lee Row:
Radiata Pine

Note:
Pre-plant spot spraying.

Lee row plants are 'staggered' between trees of front row.

Lee row trees are regularly pruned to $1/2$ height from age 5.

1 km of permeable mature shelter will protect 40 ha.



Shelter species – 2 row conifer design

N.W Row
(slower growing)



Site tolerances

Comments

Lee Row
(faster growing)



	Rainfall minimum (mm)	Coastal conditions	Snow	Exposure Exposed (E) Open (O) Sheltered (S)	Soil Fertility Low (L) Medium (M) High (H)	Site factors to consider are soil depth, rainfall (or irrigation), frost, drainage, proximity to coast, presence & stability of high water tables and exposure to wind & snow.	
Arizona Cypress <i>Cupressus arizonica</i>	625	✓	✗	EO	LM	Tolerates drought and high summer temperatures.	
Macrocarpa <i>Cupressus macrocarpa</i>	700	✓✓	(✓)	EOS	LMH	Principle forest species. Wide site tolerance. Can be damaged by snow.	Radiata pine* <i>Pinus radiata</i>
Himalayan Cedar <i>Cedrus deodara</i>	650	✓	✗	O	LM	Wide site tolerance but vulnerable to canker on wet sites.	Leyland Cypress <i>Cupressocyparis leylandii</i>
Atlas Cedar <i>Cedrus atlantica</i>	650	✗	✓	EO	LM	Graceful tree with slightly drooping branches. Drier sites. Vulnerable to drift from chemical spays.	Douglas fir <i>Pseudotsuga menziesii</i>
Douglas fir <i>Pseudotsuga menziesii</i>	750	✗✗	✓✓	S	MH	Suitable for colder inland areas and some irrigated lighter sites with well drained soils.	Macrocarpa <i>Cupressus macrocarpa</i>
Corsican pine <i>Pinus nigra</i>	600	✓	(✓)	EOS	LM	Useful species for light land and drier high country sites.	Ponderosa pine <i>Pinus ponderosa</i>
Wellingtonia <i>Sequoiadendron</i>	725	✗	✓	OS	MH	Stately. Tolerates drier climates if soils are deep. Very wind stable.	
Western Red Cedar <i>Thuja plicata</i>	850	✗✗	✓	S	MH	Tolerates wetter soils. Wind firm. Not normally suited to being planted in tandem with Radiata pine.	
Key	✓✓ very well suited	✓ well suited	(✓) marginal but okay in some situations	✗ not recommended	✗✗ definitely not suited		

Leyland cypress varieties:
'Leighton green' - Heavy and vigorous branching habit
'Naylor blue' - Narrower form and lighter branching

* Radiata pine with a Growth and Form (GF) rating of 16-17 are quite satisfactory