DUNE RESTORATION TRUST OF NEW ZEALAND

Technical Article No. 7.2

Spinifex
Kowhangatara
- guidelines for seed collection, propagation and establishment

INTRODUCTION

Along with other indigenous sand binding species, the Dune Restoration Trust of New Zealand (Dunes Trust) has been continuing with improving methods for large-scale establishment of spinifex (*Spinifex sericeus* R.Br.) for the rehabilitation of degraded foredunes. Spinifex is the major indigenous sand dune grass that occurs on foredunes throughout most of the North Island and the upper part of the South Island.

Sometimes referred to as silvery sand grass, or kowhangatara, spinifex is the dominant sand binding plant on the seaward face of the foredune where its long trailing runners and vigorous growth make it an ideal sand dune stabiliser. In many North Island dunes, spinifex forms a near continuous colony for long stretches of sandy coastline. The ecology, habitat and growth of spinifex is given in Dune Restoration Trust Technical Handbook Article No.7.1.

A local Coast Care Group planting spinifex on a foredune.

WHY REVEGETATE SAND DUNES?

Sand dunes along most parts of the coast of New Zealand have been highly modified since the time of earliest human settlement. Degradation of the vegetation cover was initially attributed to widespread grazing and fire (Cockayne, 1911) and more recently to residential and industrial development, recreational activities, spread of weeds, localised sand mining, and browsing and trampling by introduced animals. Inventories of the vegetation of sand dunes of the North Island (Partridge, 1992) and of the South Island and Stewart Island (Johnson, 1992) document some of the continuing widescale degradation of indigenous vegetation communities on coastal dunes.

The Dunes Trust is continuing to support research initiated by the former Coastal Dune Vegetation Network in improving methods of propagation and large-scale establishment of native sand binding species on foredunes. Research concentrated, initially, on developing practical techniques for establishing two major native sand binding species, spinifex (Bergin, 1999) and pingao (*Finicia spiralis*) (Bergin and Herbert, 1998). Both species were identified early last century as major sand-binding species in the native flora that were widespread and performed an important role in stabilising foredunes (Cockayne, 1911).

OPTIONS FOR ESTABLISHING SPINIFEX

Early Australian experience and revegetation programmes for over a decade in New Zealand have clearly demonstrated that there are several options for establishing spinifex on bare dunes and for promoting growth of existing spinifex stands. These include planting of nursery-raised seedlings, establishment of nursery-raised plants derived from cuttings, direct transplanting of cuttings and direct seeding on dunes.

Direct sowing of seed on dunes

Revegetation of dunes by direct seeding has been successfully used in Australia (Soil Conservation Service of NSW, 1990; Beach Protection Authority of Queensland, 1981). The method involves placing 2-3 spinifex seedheads into a spade hole up to 15 cm deep.

Direct sowing of seed on a dune by burying a seedhead. Anecdotal evidence indicates that germination may be better in years when warmer temperatures and regular rainfall is experienced.

However, direct sowing has proved to be largely unsuccessful in New Zealand. Direct sowing of seed on dunes was tested over four years in New Zealand and fewer than 10% of the trial sites contained one or more plants 12 months after seed was sown into the sand dune (Bergin, 1999). The poor success in New Zealand of direct seeding of spinifex compared to Australia may be related to the colder temperatures in the former. Success of direct seeding may also be limited by the low proportion of sound seed per seedhead. The reasons for this infertility require further research.

Where Coast Care groups are interested in direct seeding, sites that are relatively sheltered where minimal sand movement is expected are likely to increase the success from direct seeding of spinifex on dunes, especially if seed material that has a reasonable proportion of sound seed is used.

Spinifex seedling six months after sowing. Top: a sowing spot that did not receive fertiliser; bottom: several sowing spots where slow-release fertiliser was used.

Transplanting of cuttings on dunes

As with direct seeding, the transplanting of cuttings of spinifex has proved largely unsuccessful in New Zealand. The technique commonly used in Australia, where there is up to 50% survival, involves the placing of freshly harvested stolon sections up to 1 m long into trenches dug into the foredune.

Most trials and operational programmes using transplanted cuttings in New Zealand have resulted in only 5% survival. Transplanting of stolons is time-consuming in terms of both collection and planting and while much of the work is willingly carried out by volunteers in locally-based Coast Care groups, the effort is often not justified. As for direct seeding, it is likely the cooler temperatures in New Zealand compared to those in northern New South Wales and Queensland are contributing to the lack of success.

A one metre section of stolon laid in a 20 cm deep trench. The growing tip will be left exposed after most of the stolon is buried.

Nursery-raised plants from cuttings

Due to the difficulties of obtaining local collections of seed, plants can be raised from short lengths of stolons. However, this technique requires specialised nursery facilities and with high mortality, it is not considered a practical technique for raising spinifex on a large scale.

Planting nursery-raised seedlings

Trials and operational programmes have consistently shown that the most successful method for establishing spinifex on bare foredunes in New Zealand is by planting nursery-raised seedlings. For over a decade, hundreds of thousands of spinifex have been raised each year in commercial nurseries for planting on foredunes throughout its natural range. The remainder of the article will focus on establishing spinifex by planting nursery-raised seedlings.

Planting of nursery-raised seedlings is the best method of establishing spinifex on foredunes.

SEED COLLECTION AND PREPARATION

In New Zealand, collections of spinifex seed can be made in mid- to late-summer when seedheads are beginning to detach from parent plants. Preliminary investigations indicate that there is a higher proportion of viable seed collected from female plants that are immediately adjacent to male plants (Refer to Technical Article No. 7.1). Seed should only be collected where there are male plants nearby, preferably within 2 m.

Nevertheless, before large quantities of seed are collected, the proportion of formed seed in a seedhead should be assessed at the collection site.

If several formed seed are found, it is likely that seedheads collected in the vicinity do contain at least some formed seed and that collection should proceed. Repeat seed testing may be prudent where large quantities of seedheads are being collected over a large area.

Seedheads are picked by hand from vigorous female plants and placed in large hessian sacks. Several sacks per hour can usually be obtained from most sites. The easily identified smutted seedheads should not be collected as they do not contain viable seed.

Large quantities of seedheads can be collected quickly from female plants in late January and early February and stored in paper bags. Ripe seedheads should be largely straw-coloured and can be readily pulled off parent plants without pulling out plants.

Do not collect seed that is infected with a floral smut, easily recognised by the swelling partway along the spines within the seedhead.

Seed storage

Spinifex seed is stored dry in cool, dark conditions in either hessian sacks or paper bags. Rodent and bird control is essential. Hanging sacks of seedheads from the rafters of a cool shed has been found to be a practical means of keeping seed away from rodents. If seed has been collected while wet, it needs to be spread out to dry in the sun before repacking into sacks. Seedheads become straw coloured as they dry during storage and they become easier to break up into separate components. Spinifex seed was found to retain some viability after 19 months storage under cool, dry conditons.

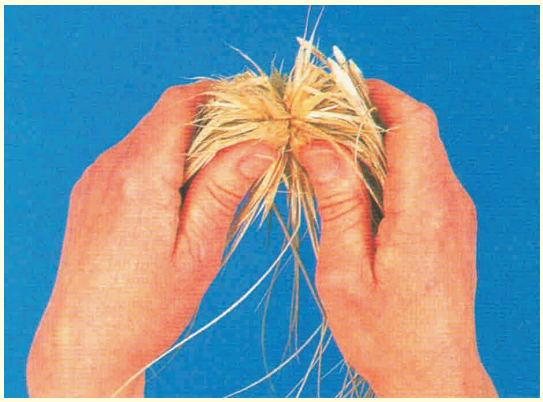
Seed viability

Seedheads vary in size, comprising 40-160 spikelets per seedhead. The number of spikelets per seedhead varies with site and with year of collection. The proportion of spikelets containing sound seed is often relatively low and can also vary between collections, ranging from 0-43%.

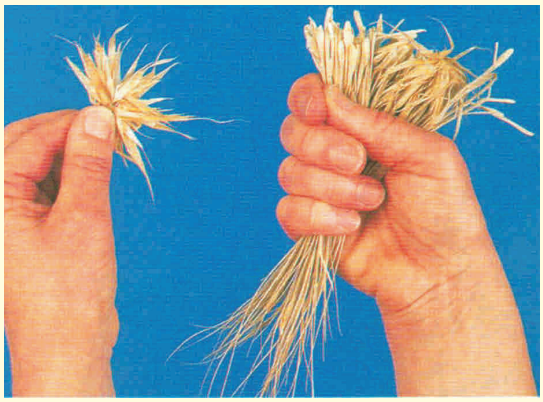
Seed preparation and sowing

From extensive nursery-based trials, the most efficient method for raising spinifex in containers is to sow seed by hand directly into the final container. Other methods of sowing whole seedheads, broken up seedheads with or without chaff, or mechanically cleaned seed have resulted in poor seedling emergence and difficulties in transplanting seedlings successfully. Small seedlings appear to be particularly sensitive to transplanting. Direct sowing of seed where formed seed has been sorted by hand is the preferred method for large-scale production of seedlings.

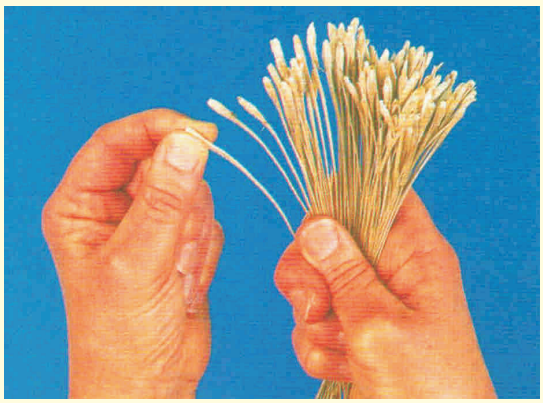
Sorting formed seed from spinifex seedheads



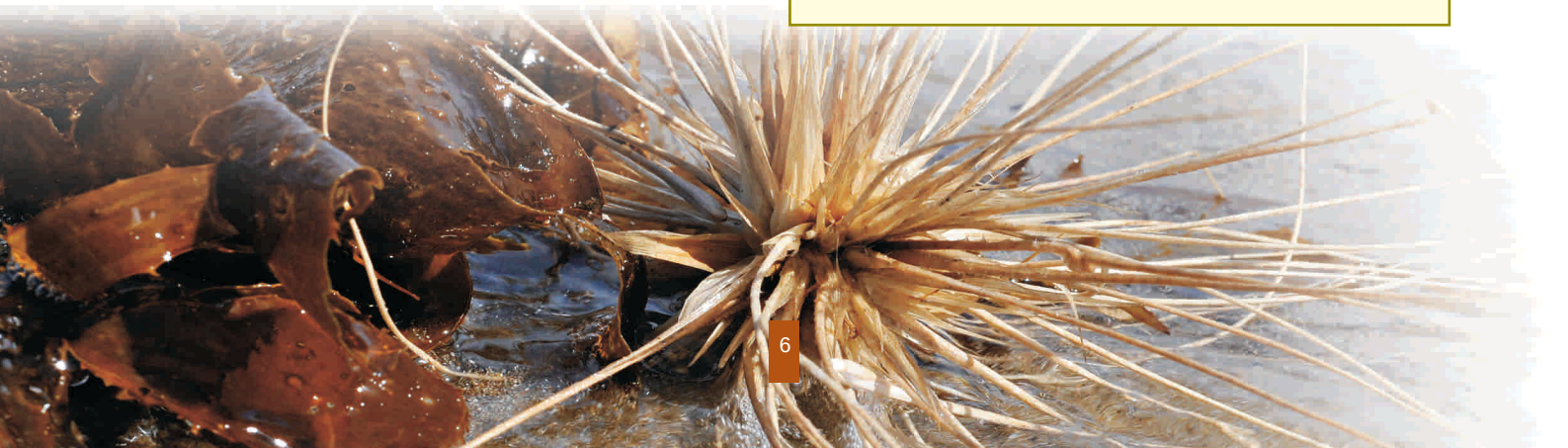
First break the seedhead in two.



Remove the large chaff to reveal the swollen base of each spine where the seed is still covered in scales.



Pressing the base of each spine between the thumb and forefinger will reveal whether a firm formed seed is present.



Hundreds of thousands of spinifex are raised in Tinus root trainers within a year at several nurseries in the Bay of Plenty for planting in coastal restoration programmes throughout the natural range of the species.

Individual spikelets containing formed seed are obtained by firstly pulling the seedhead apart into two equal parts (see box). Large pieces of chaff are then removed. The base of each spine is then exposed where the seed is enclosed in scales. Seed is assumed to be formed if the swollen base of a spine is firm to the touch. Dissection of a random sample can be used to confirm presence of formed seed where the white endosperm contents becomes exposed.

Removal of spikelets from seedheads and sorting of spikelets containing sound seed is time-consuming. Where seed formation is low (less than five per seedhead) it is impracticable to extract it.

Propagating seedlings

Spinifex can be raised in a range of containers and for up to two years in a nursery. However, large-scale commercial operations are now raising spinifex in Tinus or Hillson root trainers.

At a warm coastal nursery in the Bay of Plenty, spinifex is raised to 80 cm high within nine months of hand sowing directly in root trainers. Further details on the propagation of spinifex and the trials investigating a range of treatments are given in Bergin (1999).

Seedling costs

Seedling costs make up a considerable proportion of expenditure on dune restoration, especially if voluntary labour is used. The cost of spinifex seedlings raised in containers will depend on whether the time taken to sort viable seed for direct seeding into individual containers is included in the seedling price. Some nurseries suggest that community groups or agencies supply sorted formed seed for sowing to reduce nursery costs and other nurseries use quiet times during the winter to sort seed.

Currently, nine to 12-month-old seedlings raised in Tinus root trainers or similar-sized containers are available from North Island nurseries at about $2 each.

ESTABLISHING SPINIFEX ON DUNES

Site requirements

Spinifex grows best where sand accumulation occurs on the foredune (Maze & Whalley, 1992). Sand burial increases seed, root, shoot and stolon development of spinifex (Hesp, 1991). Spinifex planting programmes should be focussed on bare areas along the seaward face of the foredune. Once well-established, the plants will tolerate some accumulation of storm-driven sand, although large amounts if inundation or erosion will reduce survival rates.

Success of planting programmes will increase where beach users are controlled by fencing and provision of accessways where necessary, fencing to exclude grazing animals and the control of browsing pests such as rabbits.

When to plant

Survival and growth of planted sand binders including spinifex varies considerably from year to year, as well as from one season to the next (Hesp, 1989). Initial survival is largely dependent on climatic conditions including the incidence and strength of storms. Autumn-planted seedlings may be vulnerable to sand accretion or scouring during winter storms, and spring-plantings will succumb if root systems have not developed and extended into lower sand levels before early summer. In several years of trials and over many sites, there has been no significant difference in growth and survival of autumn and spring planted spinifex (e.g., Table 1). Summer planting should be avoided because the surface of the sand is likely to be too hot and dry for survival and growth of transplants.

Fertilising planted seedlings

Results from planting trials have consistently shown that applying slow-release fertiliser at planting significantly improves early establishment and growth of spinifex (Bergin et al., 1998). Spinifex seedlings planted with fertiliser have produced several stolons within a year of planting. The technique involves incorporating 30 g of slow-release NPK fertiliser to the sand around the root system as the seedling is planted.

In a typical trial located in the Coromandel Peninsula, when approximately 30 g of slow-release fertiliser was mixed into the planting hole, treated plants showed improved vigour, growth rate and stolon development within two years (Table 2; Figure 1). Treated plants produced several stolons within one year, some extending up to 8 m. In all trials, fertilised seedlings consistently had darker green colour foliage. Similar significant increases in growth with fertiliser have been observed in South Island spinifex planting trials at Taylors Mistake. It is almost certain that nitrogen from the fertiliser was responsible for the improved performance. Chronic nitrogen deficiency is a characteristic of unstable coastal sand in New Zealand (Hunter et al., 1991). In all planting trials, there has been no adverse effect on survival with application of fertiliser (Figure 2).

Table 1: Performance of spinifex seedlings planted at Whiritoa Beach South, Coromandel Peninsula.Assessments were made 18 months after spring planting and 2 years after autumn planting

	Survival %	Height (cm)	Plant spread* (cm)	Seedling vigour* 1 - 5	Root collar diameter (cm)	Average length of stolons (cm)	Sand accumulation (cm)
Autumn	83 a	40.8 a	44 a	4.1 a	13.8 a	167 a	24 a
Spring	84 a	41.8 a	41 a	4.0 b	11.5 b	74 b	27 b
Feriliser	80 a	42.1 a	53 a	4.7 a	20.2 a	257 a	32 a
No feriliser	87 a	40.6 a	32 a	3.5 b	6.6 b	14 b	15 b

*Vigour score: 1 - weak, 2 - unthrifty, 3 - average, 4 - good, 5 - robust
*Plant spread calculated as square root of (length x breadth).
Within groups, values followed by the same letter are not significantly different (p=0.05)

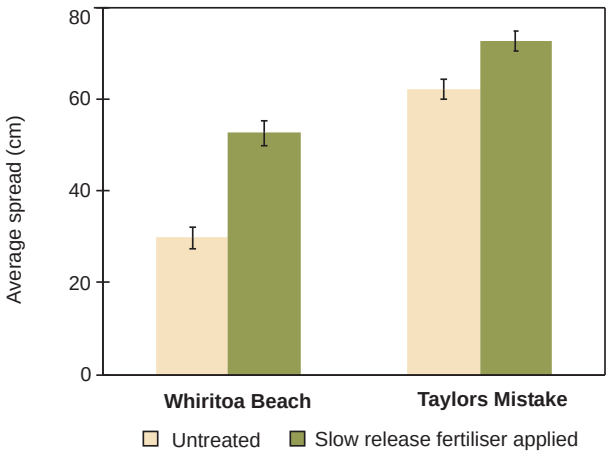


Figure 1: Average extent of planted spinifex in two trials after one year. Bars show standard errors of means.

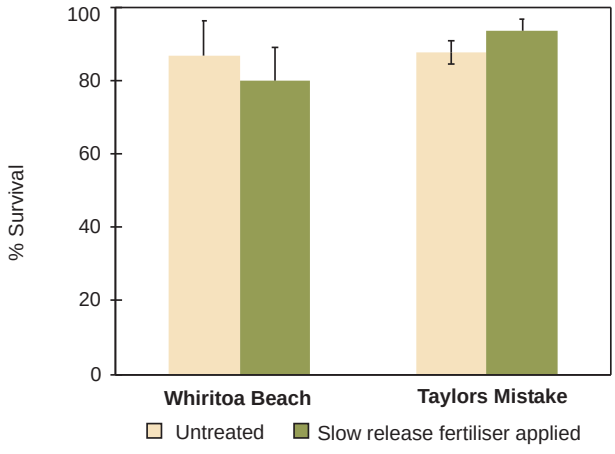


Figure 2: Survival of planted spinifex in two trials after one year. Bars show standard errors of means.

Coast Care groups have used other slow-release N fertiliser types (e.g., Growtabs) with apparent success. Care is required in ensuring only slow-release fertiliser formulations are used. The use of fast-release fertiliser formulations (e.g., Urea - 46% N) incorporated in the planting hole will kill planted seedlings.

These nursery-raised spinifex seedlings were planted at Tairua Beach with slow-release NPK fertiliser. Planted groups have very high survival and most plants have runners up to 8 m long within eight months as shown here..

A small handful (30 gm) of slow-release NPK fertiliser is applied to each seedling as it is being planted by incorporating the fertiliser in the sand surrounding the intact plug of potting mix and root system. Seedlings are planted deeply with root collars placed at least 10 cm below the level of the sand surface.

PLANTING TECHNIQUE AND PATTERN

Spinifex grown in root trainers can be planted quickly in spade holes. Deep planting (sand level at least 10 cm above surface of potting mix) will maximise root contact with moist sand horizons and result in greater survival and better growth, especially under conditions of moderate sand scouring by wind. The use of plants at least 60 cm high will allow deep burial.

Spinifex plants are frequently used to repair gaps in the vegetation cover on the seaward face of the foredune. Gaps or blowouts result from localised disturbance and are common around accessways and other high use areas. Large-scale planting of large sections of degraded or reshaped foredunes will take thousands of plants. Plant spacing must be related to local site factors. Dense colonies with numerous stolons spreading several metres beyond plot boundaries have developed from spacings of 50-60 cm with fertiliser treatment. Dense planting on particularly exposed sites vulnerable to wind erosion will increase the likelihood of success. In relatively sheltered sites where high survival rates and rapid growth are expected, 1 m spacing may be adequate. The aim is to achieve dense cover as rapidly as possible.

Natural populations tend to consist of large patches of single sex plants, probably originating vegetatively from one individual. Large-scale planting of individuals grown from seed is likely to result in more even proportions of male and female plants within colonies.

Maintenance of fencing, accessways and signs will be required to protect planted spinifex areas at heavily used beaches.

MAINTENANCE AND CARE

Regular inspection of planted sites is essential. Although spinifex appears to be less palatable to animals than pingao, browsing (largely by rabbits) does occur, so an ongoing pest animal control programme is essential.

Most damage of planted spinifex areas is likely to be from beach users. All planted areas where disturbance by beach users is likely will require fencing, signage and beach accessways where necessary.

Plant survival can vary from one year to next and losses due to occasional high seas or storms may occur at any time of the year. Where losses of spinifex have occurred, replanting during the following autumn to early spring will be necessary to ensure development of an even vegetation cover.

Spinifex heavily browsed by rabbits.

Spinifex seedlings filling a gap in the foredune vegetation cover.

REFERENCES

Beach Protection Authority of Queensland, 1981: *Sand spinifex grass. Coastal sand dunes. Their vegetation and management.* Beach Protection Authority of Queensland, Leaflet No. IV-01. 2p.

Bergin, D. 1999: Spinifex on coastal sand dunes. Guidelines for seed collection, propagation and establishment. *Coastal Dune Vegetation Network Technical Bulletin No. 2.* New Zealand Forest Research Institute Limited. 20p.

Bergin, D. O., Herbert, J. W. 1998: Pingao on coastal sand dunes. Guidelines for seed collection, propagation and establishment. *Coastal Dune Vegetation Network Technical Bulletin No. 1.* New Zealand Forest Research Institute Limited. 20p.

Bergin, D. O., Kimberley, M. O.; Ede, F. J. 1998: Revegetation of sand dunes using spinifex (*Spinifex sericeus*) in New Zealand. *Proceeding of New South Wales Coastal Conference, November 1998, Batemans Bay, NSW, Australia.* 6p.

Cockayne, L.1911: *Report on the dune areas of New Zealand plants, their geology, botany and reclamation.* Parliamentary Paper C. 13. Department of Lands, Wellington, New Zealand. 76p.

Hesp, P. A. 1989: A review of biological and geomorphological processes involved in the initiation and development of incipient foredunes. *Proceedings of the Royal Society of Edinburgh*, 96B: 181-201.

Hesp, P. A. 1991: Ecological processes and plant adaptions on coastal dunes. *Journal of Arid Environments*, 21: 165-191.

Hunter, I.R,; Rodgers, B.E.; Dunningham, A.; Prince, J.M; Thorn, A.J. 1991: An atlas of radiata pine nutrition in New Zealand. *New Zealand Ministry of Forestry Forest Research Institute Bulletin No. 165*, Rotorua, New Zealand.

Johnson, P. N. 1992: *The sand dune and beach vegetation inventory of New Zealand. II. South Island and Stewart Island.* DSIR Land Resources Scientific Report No. 16. Christchurch, New Zealand. 278p.

Maze, K. M.; Whalley, R. D. B. 1992: Effects of salt spray and sand burial on *Spinifex sericeus* R. Br. *Australian Journal of Ecology, 17*: 9-19.

Partridge, T. R. 1992: *The sand dune and beach vegetation inventory of New Zealand. I. North Island.* DSIR Land Resources Scientific Report No. 15. Christchurch, New Zealand. 253p.

Soil Conservation Service of NSW, 1990: *Coastal dune management. A manual of coastal dune management and rehabilitation techniques.* Soil Conservation Service of NSW, Sydney. 76p.

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'To see the majority of New Zealand dunes restored and sustainably managed using indigenous species by 2050".