PLANTING SEEDLINGS, SOWING SEED AND TRANSPLANTING RUNNERS OF SPINIFEX ON COASTAL FOREDUNES, COROMANDEL PENINSULA

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INTRODUCTION

Planting seedlings

Spinifex (*Spinifex sericeus*) is the key indigenous sand binding plant on coastal foredunes on most parts of the sand dune coast throughout the North Island and the upper regions of the South Island. As part of the ***Forest Research*** Sand Dune Research Programme and the Coastal Dune Vegetation Network (CDVN), techniques for large scale propagation and establishment of spinifex are being investigated. Although some spinifex seedlings have been raised in nurseries and pilot planting trials established by ***Forest Research*** over recent years, there have been difficulties in raising large quantities of seedlings on a consistent basis for both trial and operational scale plantings. Small pilot planting trials show that spinifex seedlings can be successfully planted on a bare foredune (Bergin & Herbert 1997).

A current research priority by the CDVN in collaboration with Naturally Native NZ Plants Ltd, Oropi, is the development of large scale nursery techniques for raising spinifex seedlings (Ede, Bergin & Fair 1998). Up to 1200 seedlings were produced in the first year of trials and available for planting in trials on sand dunes. All seedlings were incorporated into a planting trial on several Coromandel Peninsula beaches evaluating a range of treatments.

Seeding on dunes

Direct seeding of spinifex seed onto to dunes is used on a large scale in New South Wales and Queensland with considerable success (Soil Conservation Service of NSW 1990; Beach Protection Authority of Queensland 1981). Small scale direct seeding trials of spinifex seed onto bare foredunes have been undertaken in two regions in New Zealand by the *Forest Research* in collaboration with Environment Waikato and Christchurch City Council. Generally, results have been poor due to a low proportion of formed seed in seed collections used (Bergin & Herbert 1997). Assessment of the 1998 collections of spinifex seed indicate higher proportions of formed seed compared to previous years where seed has been collected and assessed. Therefore, a further direct seeding trial was established on two Coromandel beach sites to compare performance with planted seedlings.

Runners

Transplanting of spinifex runners has been used in Australia with some success (Bergin 1993) and with generally poor results to date in pilot trials and operational scale attempts in New Zealand (Bergin & Herbert 1997). Transplanting of runners were therefore evaluated incorporated in this trial on two Coromandel sites.

OBJECTIVES

- To evaluate the performance of nursery-raised seedlings of spinifex planted on three beaches on the Coromandel Peninsula.
- To determine the growth response of spinifex seedlings to application at planting of a slow-release fertiliser.
- To compare the performance of spinifex planted on an upper and lower foredune site at one location.
- To monitor the germination and growth of spinifex seed direct sown onto bare foredunes at two beaches on the Coromandel Peninsula.
- To monitor the performance of spinifex runners onto a bare foredune site at two locations.
- To compare performance of spinifex with autumn and spring planting of seedlings, sowing of seed and transplanting of runners.

ASSESSMENT OF SEEDLINGS, SEED AND RUNNERS

Seedlings

Seed collected from eastern beaches of the Coromandel in early 1997 was sown in October in 1997 at the nursery of Naturally Native NZ Plants Ltd, Oropi, and pricked into Hillsons rootrainers in January 1998. Height of the green leaf portion for the longest leaf of each plant were measured for a sample of 20 seedlings from each provenance at time of autumn planting in mid April 1998. Root collar diameters were also taken for the largest diameter stem at the base of each seedling for same seedling sample. Heights and root collar diameters are summarised in Table 1. Overall, height of seedlings 6 months after sowing were about 55 cm with root collar diameter about 5 mm.

Table 1: Height and root collar diameter of nursery-raised seedlings of spinifex used in autumn planting trials at several beaches on the Coromandel Peninsula

Provenance	Average pulled up height (cm)	Average root collar diameter (mm)
Whiritoa	59.1	4.95
Whangamata	52.6	4.65
Tairua	51.5	5.35
Matarangi	55.7	5.1

Roots systems of raised seedlings were occupying most parts of the rootrainer cavity but there was room for more root development. Consequently, seedlings needed to be handed carefully to ensure that potting mix remained largely undisturbed during planting. At least half the seedlings were growing new tillers from the base. Considering seedlings were only sown six months previously and seedlings pricked into the rootrainers only 3 months

earlier, root systems and shoots have developed well. Earlier seed sowing and pricking out are therefore likely to give larger more robust seedlings in 12-15 months after sowing.

Seed

In contrast to some years, the proportion of formed seed in each spike (seedhead) of spinifex seed collections made in 1998 from some sites along the eastern Coromandel coast are reasonable high (Table 2).

Table 2: Proportion of formed seed in spinifex seed collected from Coromandel beaches in 1998.

Provenance	Seed per spike or seedhead (%)
Whiritoa	7.4
Whangamata	32.7
Tairua	29.6
Matarangi	15.4

Runners

Australian programmes use 60 cm to 1 m lengths of runner tips from spinifex stolons with some 50% survival estimated one year after transplanting (Bergin 1993). Inspection of dunes in autumn 1998 indicated there was reasonable numbers of newly grown stolons on some beaches. In contrast, earlier pilot trials have shown there are difficulties in collecting newly grown spinifex runners in early spring due possibly to the lack of growth in winter and burial of runners by sand in winter storms. This trial compared availability and performance of transplanted spinifex runners in autumn and spring.

TRIAL SITES, LAYOUT AND TREATMENTS

Trials were established at three Coromandel beaches - Whiritoa, Whangamata and Tairua in collaboration with local community-based Beach Care groups. All trials were located on the foredune where the indigenous sand binders are expected to perform best where there is likely to be some sand movement. There was either no vegetation present or only scattered *Carex* spp. and sand convolvulus (*Calystegia soldanella*).

Whiritoa Beach

The trial was located at the southern end of the beach adjacent to the Urupa where previously trials of sand binders have been established in collaboration with the Te Koha O Rapa Tio Tio Trust. Plots were planted within gaps and along the seaward edge of previous plantings and natural plant colonies. The site is a flat foredune with a large sand plain on the seaward side that rarely becomes inundated with high seas during storms. The trial comprised:

- Eight plots of planted spinifex seedlings, four with fertiliser and four without fertiliser - 16 seedlings per 3 m diameter plot.

- Eight plots of sown seed, four with fertiliser and four without fertiliser - 15 sowing spots per 2 m diameter plot.
- Eight plots of runners, four with fertiliser and four without fertilsier - three runners per 2 m diameter plot.

A list of plot treatments is given in Appendix 1 for the Whiritoa site.

Whangamata Beach

The planting trial was located approximately 50 m eastward of the Mooloo Crescent accessway near the centre of the main beach. The site is a relatively steep 3-5 m long slope formed since an erosion scarp was created during storms the previous winter. Plots were sited along the slope parallel to the beach. The trial comprised:

- Eight plots of planted spinifex seedlings, four with fertiliser and four without fertiliser - 20 seedlings per 3 m diameter plot for Plots 1-6, 12 seedlings per 3 m diameter plot for Plots 7-8.

A list of plot treatments is given in Appendix 2 for the Whangamata site.

Tairua Beach

This site was a largely unvegetated area approximately 30 m x 40 m on a long sloping foredune near the centre of Tairua Beach. A fenced board and chain accessway traversed the area near the northern side. For the planted seedlings only, plots were established on two sites - an upper foredune site and a lower foredune site. The trial comprised:

- Eight plots of planted spinifex seedlings, four with fertiliser and four without fertiliser - 15 seedlings per 3 m diameter plot on upper foredune site.
- Eight plots of planted spinifex seedlings, four with fertiliser and four without fertiliser - 15 seedlings per 3 m diameter plot on lower foredune site.
- Eight plots of sown seed, four with fertiliser and four without fertiliser - 15 sowing spots per 2 m diameter plot.
- Eight plots of runners, four with fertiliser and four without fertiliser - five runners per 2 m diameter plot.

A list of plot treatments is given in Appendix 3 for the Tairua site.

TRIAL DESIGN AND ESTABLISHMENT

Trial design

The trials were a Randomised Complete Block design with four replicates per treatment. Blocks contain paired plots with and without fertiliser. All plot were either 2 m (seed & runners) or 3 m (planted seedlings) diameter circular plots. Distances between edges of adjacent plots was a minimum of 1 m. At Tairua and Whiritoa, 50 mm x 25 mm treated wooden peg was placed at 60 cm above sand level to identify each plot or pairs of plots. All sites were mapped to enable relocation of plots for future monitoring.

Planting

Planting involved placing seedlings in deep spade holes dug at a spacing of 50-70 cm apart within the 3 m diameter circular plot. Seedlings were planted about 50 cm below root collar to ensure root systems were within the lower moist zones in the sand and to improve chances of survival if there were any decreases in sand level.

Sowing seed
Seed was direct sown on dunes using the NSW method of placing a handful of intact seedheads (approximately 3-4 seedheads) into a spade hole about 100 mm deep. Fifteen sown spots were placed at approximately 50 cm spacing within 2 m diameter circular plots.

Transplanting runners
Three or five 1 m long runner tips collected from nearby established spinifex colonies were placed into trenches within a 3 m diameter plot. Trenches were 10-15 cm deep with about 10 cm of the runner tip left exposed. Runners were transplanted with tips facing downhill.

Fertiliser application
Half of the seedling, seed and runner groups at all sites were fertilised. Fertilising involved incorporating approximately 30-40 g of the slow-release fertiliser Magamp (medium granules) with each seedling, seed sowing spot and runner trench at the time of establishment. For planted seedlings, fertiliser was incorporated into the sand evenly around the plug of potting mix containing the root system as the seedling was planted ensuring fertiliser was not placed at the base of the planting hole or on the surface of the sand. For seed sowing and runner transplanting, fertiliser was evenly spread around the seed and runner respectively taking care not to place all fertiliser at the bottom of the sowing pits and runner trenches.

Spring and autumn comparison
At the three beaches, spinifex seedlings were planted in autumn (April 1998) and in spring (October 1998). Autumn and spring seed sowing and transplanting of runners were compared at the Tairua and Whiritoa sites.

MONITORING AND MAINTENANCE

All trials were established in collaboration with local Beach Care groups and Environment Waikato. Beach Care members assisted. All sites were inspected every 3 months by ***Forest Research*** with full assessment of trials one year after establishment for both autumn and spring planting and sowing. Growth parameters assessed for seedlings included survival, plant height, plant cover (width x breadth of the live crown of each plant) and a subjective assessment of plant vigour. For seed sowing plots, weekly inspection where conducted by the Tairua Beach Care Group, particularly Stan and Kath Ayling. This made it possible to identify when seedlings emerged at this site.

FIRST YEAR RESULTS

Performance of spinifex was significantly better at the Tairua Beach site than at the Whiritoa and Whangamata sites. At Whiritoa, large quantities of sand inundated the autumn establishment trial resulting in poor growth of planted seedlings and poor survival of runners. Emergence of seedlings from buried seed was not observed. At Whangamata where only seedlings had been planted, good early survival and growth, particularly of fertilised plots was observed for both autumn and spring plantings but high seas during strong easterly gales in late spring has reduced seedling numbers significantly. Early results for the Tairua Beach site are briefly presented and discussed.

Nursery-raised spinifex seedlings planted at the Tairua Beach site show high early survival for both autumn and spring plantings (Table 3). However, fertilised seedlings are consistently more vigorous compared to non-fertilised seedlings. Stolons had started to growth with the autumn seedlings planted 9 months earlier with a considerably greater number and growth of runners of fertilised spinifex. Many fertilised plants produced several stolons exceeding 3 m in length.

Table 3: ***Performance of planted nursery-raised seedlings established in Autumn and Spring 1998, Tairua Beach. Seedlings were assessed in January 1999.***

	Autumn				Spring			
	Survival (%)	**Vigour score***	**No. of runners**	**Average runner length (cm)**	**Survival (%)**	**Vigour score***	**No. of runners**	**Average runner length (cm)**
Fertiliser	96.7	4.9	20.4	299.4	94.2	4.6	0	0
No fertiliser	93.3	2.1	0.9	50.5	96.7	2.3	0	0

* Vigour score : 1 - weak, 2 - unthrifty, 3 - average, 4 - good, 5 - robust.

The relatively sheltered site at Tairua Beach has probably contributed to more success with emergence of seedlings from direct seeding compared to previous trials. Here there was less than 3 cm of sand movement within the first 6 months of establishment (Table 4). Up to 60% of the total number of burial spots over 8 different plots had at least one seedling established 6 months after sowing in autumn with up to 45% for spring sowing. Some burial spots had over 20 germinated seedlings with faster emergence of seedlings from spring-sown seed than autumn-sown seed. There was no seedling emergence from autumn sown seed until the warmer spring temperatures. As autumn-sown seed may take several months to germinate, risk of failure is increased due to excessive sand movement. Where fertiliser had been applied, usually only one or two seedlings survived but had benefited with increased growth and better health compared to densely stocked and unthrifty small seedlings that had germinated in non-fertilised burial spots.

Table 4: ***Performance of seed burial spots for spinifex seed directly sown on dunes in Autumn and Spring 1998, Tairua Beach. The trial was assessed in January 1999.***

	Autumn			Spring		
	Survival (%)	**Vigour score***	**Height (cm)**	**Survival (%)**	**Vigour score***	**Height (cm)**
Fertiliser	20	4.3	15	45	4.5	16
No fertiliser	60	1.0	7.5	38.3	1.7	6.5

* Vigour score : 1 - weak, 2 - unthrifty, 3 - average, 4 - good, 5 - robust.

Previous ***Forest Research*** trials on the same and at other sites has resulted in only 5% of transplanted stolon sections surviving. To date, up to 20% of stolons have survived from the autumn planting and up to 70 for the more recent spring transplanting at the Tairua Beach site (Table 5). Interestingly, survival was greater for non-fertilised stolon sections although the few survivors in fertilised plots did have better growth and vigour. The higher survivals to date at Tairua may also be due to the relative ease of locating sufficient quantities of actively growing runners on this site compared to previous trial sites. Considerable sections of existing spinifex stands at Tairua Beach have been fertilised by the local Beach Care group over the last 2 years resulting in improved vigour including stolon production.

Table 5: Performance of stolon sections transplanted in Autumn and Spring 1998, Tairua Beach. The plots were assessed in January 1999.

	Autumn			Spring		
	Survival (%)	**Vigour score***	**Height (cm)**	**Survival (%)**	**Vigour score***	**Height (cm)**
Fertiliser	5	5	25	35	5	35
No fertiliser	20	2.5	9	70	3.3	25

* Vigour score : 1 - weak, 2 - unthrifty, 3 - average, 4 - good, 5 - robust.

CONCLUSIONS

Early results from these trials confirm results from previous planting trials (Bergin, Kimberley & Ede 1998) that nursery-raised spinifex seedlings can be successfully established on bare foredunes on the eastern coastal sites of the Coromandel Peninsula. Spinifex seedlings responded positively to application of the slow-release fertiliser Magamp at the rate of 30g per plant incorporated with the sand at time of planting. As with pingao (*Desmoschoenus spiralis*), a slow-release fertiliser should be used with any operational-scale planting of spinifex.

Seed sown directly on dunes at Tairua Beach has shown that seed will germinate on dunes. Up to 60% of burial spots with at least one live seeding although the long term fate of these small seedlings is yet to be observed. Previous trials in New Zealand had achieved less than 10% of burial spots with at least one seedling although direct seeding of dunes in Australia is a proven technique. There has also been greater survival of runners at Tairua compared to previous trials. These early results indicate that direct seeding or transplanting of cuttings for spinifex may be practical on some sheltered sites in favourable years. However, the planting of nursery-raised spinifex seedlings with fertiliser will give considerably greater success on a wide range of sites and is therefore likely to remain the preferred method for revegetation of bare dunes. Continued emphasis on developing large-scale techniques for raising spinifex seedling in nurseries at reasonable cost is required.

REFERENCES

These trials have been established, maintained and monitored in collaboration with Beach Care groups at Tairua Beach, Whangamata Beach and Whiritoa Beach. With the Beach Care groups, Environment Waikato supplied and organised materials including pegs, fertiliser and fencing for each of the trial sites and Naturally Native NZ Plants Ltd provided the spinifex seedlings. The enthusiasm and assistance from the local Beach Care members at each site is gratefully acknowledged: in particular Stanley and Kathleen Ayling who undertook intensive monitoring of the planting and seeding trial at Tairua Beach; Tony Wilson, Tairua Beach; Brian Walmsley and Bob Taite, Whangamata Beach; and Te Koha O Rapa Tio Tio Trust, Whiritoa Beach.

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APPENDIX 1 - List of plot treatments for spinifex seedlings, seed and runners established at Whiritoa Beach, April 1998 (plots marked A) and October 1998 (plots marked S).

Block No.	Plot No.	Plant type	Fertiliser
1	1	Seedlings	Yes
1	2	Seed	No
1	3	Seedlings	No
1	4	Seed	Yes
1	5	Runners	No
1	6	Runners	Yes
2	1	Seedlings	Yes
2	2	Runners	Yes
2	3	Seedlings	No
2	4	Runners	No
2	5	Seed	No
2	6	Seed	Yes
3	1	Seed	Yes
3	2	Seed	No
3	3	Seedlings	No
3	4	Runners	No
3	5	Runners	Yes
3	6	Seedlings	No
4	1	Seed	No
4	2	Seedlings	Yes
4	3	Seed	Yes
4	4	Seedlings	No
4	5	Runners	Yes
4	6	Runners	No

APPENDIX 2 - List of plot treatments for spinifex seedlings established at Whangamata Beach, April 1998.

Block No.	Plot No.	Plant type	Fertiliser
1	1	Seedlings	Yes
1	2	Seedlings	No
2	3	Seedlings	Yes
2	4	Seedlings	No
3	5	Seedlings	Yes
3	6	Seedlings	No
4	7	Seedlings	Yes
4	8	Seedlings	No

APPENDIX 3 - List of plot treatments for spinifex seedlings, seed and runners established at Tairua Beach, April 1998 (plots marked A) and October 1998 (plots marked S).

Block No.	Plot No.	Plant type	Fertiliser
1	1	Seedlings	No
1	2	Seedlings	Yes
1	3	Seed	No
1	4	Seed	Yes
1	5	Runners	No
1	6	Runners	Yes
2	7	Seedlings	No
2	8	Seedlings	Yes
2	9	Seed	No
2	10	Seed	Yes
2	11	Runners	No
2	12	Runners	Yes
3	13	Seedlings	No
3	14	Seedlings	Yes
3	15	Seed	No
3	16	Seed	Yes
3	17	Runners	No
3	18	Runners	Yes
4	19	Seedlings	No
4	20	Seedlings	Yes
4	21	Seed	No
4	22	Seed	Yes
4	23	Runners	No
4	24	Runners	Yes
5	25	Seedlings	No
5	26	Seedlings	Yes
6	27	Seedlings	No
6	28	Seedlings	Yes
7	29	Seedlings	No
7	30	Seedlings	Yes
8	31	Seedlings	No
8	32	Seedlings	Yes