DUNE RESTORATION TRUST OF NEW ZEALAND

Technical Article No. 7.1

Spinifex
Kowhangatara
- ecology, habitat and growth

INTRODUCTION

Spinifex (*Spinifex sericeus* R.Br.) 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, it 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.

Spinifex often occurs with other indigenous sand binding species on the foredune including pingao (*Ficinia spiralis),* nihinihi (sand convolvulus, *Calystegia soldanella*), and hinarepe (sand tussock, *Poa billardierei*).

PLANT DESCRIPTION

Spinifex is a stout perennial grass with strong creeping runners or stolons. Leaves are usually 5-10 mm wide and up to 38 cm long (Craig, 1984). The stolons can be up to 20 m long with internodes up to 38 cm long. Each node produces adventitious roots and upright, silvery green leaves that are hairy on both surfaces (McDonald, 1983). At intervals of 10-15 cm, new nodes are formed from which roots emerge, take root and eventually a discrete plant will form where there is sufficient space that is independent of the original stolon (Hesp, 1982).

Vigorous spinifex on a foredune showing the upright silvery green leaves and long creeping runners or stolons that spread rapidly to occupy bare sand.

Flowering and seedheads

Spinifex is dioecious, i.e. male and female flowers are borne on separate plants. Male and female plants form colonies of equal size (Connor 1984; Maze and Whalley, 1990). Flowers of both genders begin to appear in spring when pollination occurs.

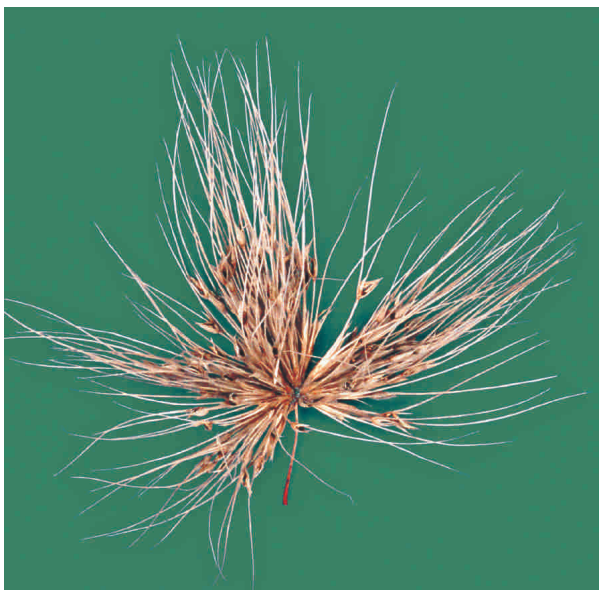
The male plant produces pale brown, branched, but compact flowers about 5 cm long on short branches (Harty and MacDonald, 1972). The male flowers mature in October-November when the brown pollen sacs are most conspicuous. The flower heads persist for several months and are easily distinguished from the female flowers.

Spinifex male flowers (left) and female flowers (right) are borne on separate plants.

The flowers of the female plant develop into large, softly-spiny, spherical seedheads about 20-30 cm in diameter. The seedhead is commonly a single terminal head but second or third heads may develop on one stem. The head contains many spine-like branches 10-15 cm long. Each spine has a single spikelet just above its base although not all spikelets will contain formed seed. The flowerhead matures in mid- to late-summer (late January to early March) when it becomes detached from the plant and the spines are an aid to wind dispersal of seed along the shoreline. It is easily recognised by the seedheads tumbling along the beach or being caught in other vegetation.

Floral smut

Both male and female flowers can become infected by a floral smut, *Ustilago spinificis* (Osborn, 1922). High infection rates have been found in both Australia and New Zealand. The appearance of the diseased female flower is strikingly different from normal as infected spikelets have a swelling 1.5-4 cm above the base of each spine. Kirby (1988) found that almost all infected seedheads were destroyed by the smut and estimated that in infected populations, the reproductive effect of the smut can be up to 20% of seedheads. As seed of infected seedheads is not likely to be viable, these seedheads have been avoided for revegetation purposes.



Both male flowers and female seedheads of spinifex can be infected by a floral smut. The presence of smut is easily recognised with female seedheads by the presence of a swelling on each spine with black spore masses. Smut-infected seedheads do not contain viable seed and should not be collected.

Proximity of males and females

Preliminary research to determine if proximity of male and female plants influences the formation of seed has been carried out along part of the Bay of Plenty coast. Initial results from a survey of mixed male and female spinifex colonies indicate that seed formation may be positively correlated to proximity of male and female plants (Bergin et al., 1999).

The pilot trial indicated that the proportion of formed seed in seedheads increased where female colonies were in close proximity (within 3 m) to a male plant (Figure 1). The proportion of formed seed increased from 20% in females isolated from males to 45% in females in close proximity to males. Furthermore, there was a significantly greater proportion of formed seed from seedheads collected from female plants that had several male plants nearby (Figure 2). The proportion of formed seed increased from 30% or less for females with only one male plant within 5 m to 70% in females that had four male plants within 5 m. The survey indicated that large female colonies have significantly lower seed formation probably due to the exclusion of male plants in the local area. In addition, location of male and female plants in relation to prevailing wind patterns during time of pollination in October may influence the proportion of viable seed.

Left: A pilot study and supporting anecdotal evidence from random sampling has shown that there is a higher proportion of formed seed from seedheads collected from female spinifex seed where there are male spinifex plants in close proximity.

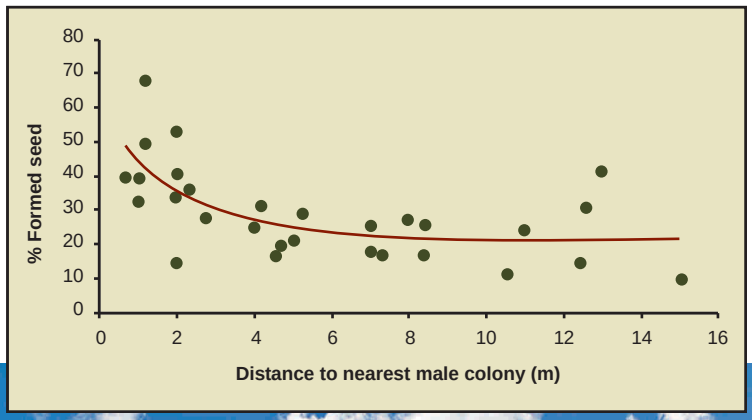


Figure 1: Relationship between percentage of formed seed in seedheads collected from female colonies and distance to the nearest flowering male colony.

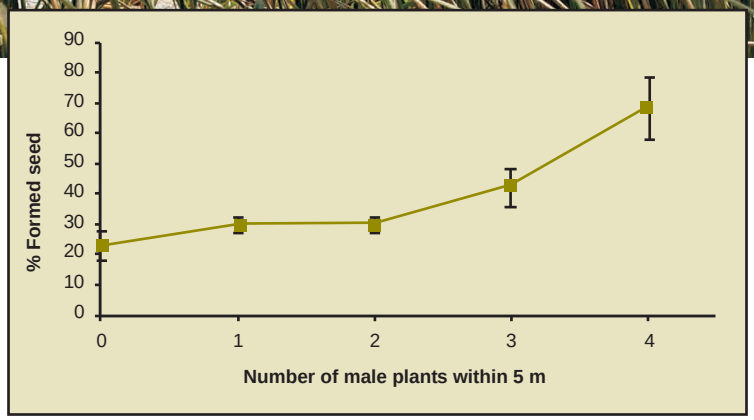


Figure 2: Relationship between percentage of formed seed found in seedheads from a female colony and the number of flowering male colonies with 5 m.Vertical bars indicate standard errors.

Seed viability

The proportion of formed seed within spinifex seedheads is often low and tends to vary considerably between locations and years. Details of methods used to determine the proportion of formed seed are given in Bergin (1999). Briefly, this involves carefully pulling the seedhead apart and pressing the base of each spine between the thumb and forefinger where the seed is enclosed. A spine with a swollen base contains a formed seed but not all formed seed may have been pollinated and therefore may not be viable seed.

In an investigation of seedheads collected from three spinifex stands along Bay of Plenty and Coromandel beaches, it was found that spinifex does have a relatively low proportion of formed seed (Table 1). There was also no significant difference in viability between the three beaches surveyed. Germination studies found that little more than 60% of the formed seed was in fact viable.

Australian studies indicated that although seedhead production is increased with application of fast-release fertiliser, there is no increase in the proportion of viable seed (McKenzie et al., 1989). A trial in New Zealand also found there was no significant difference in either the percentage of formed seed or germination of seed between fertilised and unfertilised plants growing at one site (Table 2) confirming that fertilising of dunes does not increase proportion of seed viability.

Further phenology studies

Studies in New Zealand on factors affecting seed viability of spinifex have been limited to date. While anecdotal evidence from random sampling of seedheads from close proximity to males versus seed from seedheads from isolated females confirms that high proportions of viable seed can be expected from female in close proximity to males, more comprehensive investigation is required. Similarly, more research is required into the influences of weather patterns at time of pollination during spring on seed viability, including wind direction and occurrence of rain.

Table 1: Viability of spinifex seed at the three collection sites

Beach	Number of plants	Formed seed (%)		Germination (%)	
		Mean	Std. error	Mean	Std. error
Matarangi	8	19.1	4.0	61.0	5.1
Papamoa	29	29.3	2.5	58.6	1.5
Tairua	8	28.1	3.1	69.1	3.5
All	**45**	**27.3**		**60.9**	

Table 2: Comparison of seed viability from fertilised and unfertilised sections of Papamoa Beach

Fertiliser	Number of plants	Formed seed (%)		Germination (%)	
		Mean	Std. error	Mean	Std. error
No	17	26.4	2.0	57.1	2.0
Yes	12	33.3	5.2	60.8	2.2
All	**29**	**29.3**		**58.6**	

DISTRIBUTION

Spinifex occurs on sand dunes throughout the North Island and the northernmost part of the South Island. As spinifex prefers warmer climates, its last known natural southern limit is likely to have been determined by temperature.

The current distribution of spinifex has been significantly influenced by human modification. Throughout the natural range of spinifex from Christchurch northward, most sand dunes probably had vast tracts of the species. However, the extent of spinifex even in the warmer North Island sites has very likely reduced significantly even since Maori times. Dune vegetation had been burnt by Maori and this would have initiated the decline of spinifex along with other sand dune species. With the introduction of both domestic and feral grazing animals by early European settlers along with introduction of exotic plants, there was a dramatic effect on the dune systems.

While the other major indigenous sand binder pingao is highly palatable, spinifex can be browsed. The widescale grazing of domestic animals combined with development of duneslands into pastoral and exotic forestry landuses and for settlement would have seen the degradation of many spinifex dunes. The southern extent of the species has therefore retreated northward in the face of this human-induced modification of the dunes leading to conjecture as to what may have been the southern limit of the species. For instance, the last known most southern natural spinifex in Christchurch was noted by Simpson (1974) where one male plant was recorded in 1944. However, there is no mention by Pegg (1913) or Cockayne (1927) in specific descriptions of plants covering the dunes at New Brighton, Canterbury, of the presence of spinifex. Pingao was the dominant indigenous plant and marram grass (*Ammophila arenaria*) the dominant exotic sand binder along these Christchurch dunes.

In an inventory of the vegetation sand dune and beach systems of New Zealand, Partridge (1992) and Johnson (1992) identified the locations of spinifex on these very much modified coastal systems throughout the North Island and South Island respectively (Figure 3).

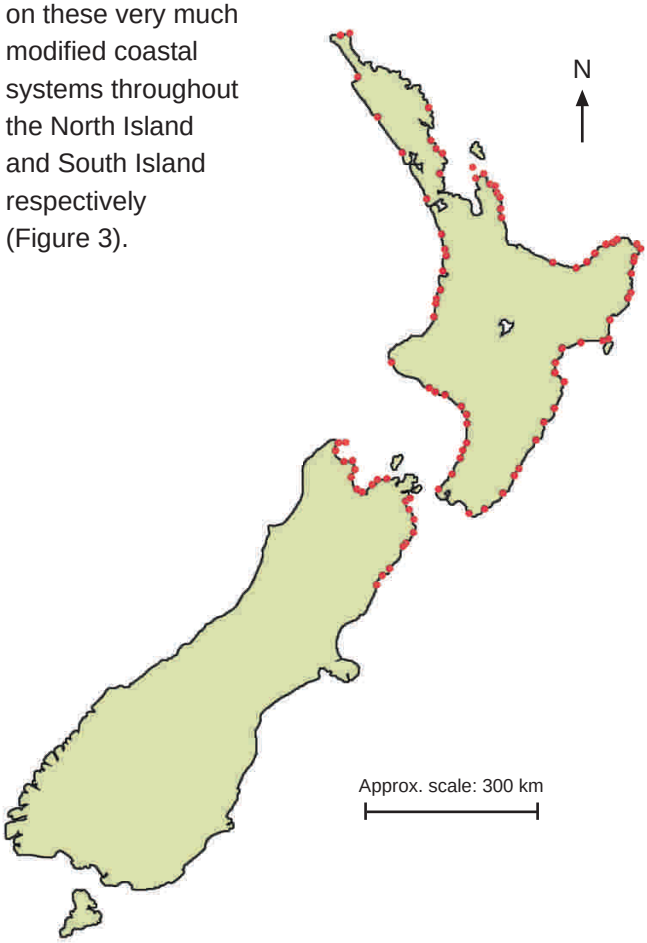


Figure 3: Distribution of spinifex on sand dunes in New Zealand as determined in a survey of coastal vegetation in the 1980s (Partridge, 1992; Johnson, 1992).

Although the rapid survey, by Partridge and Johnson was carried out in a fragmentary fashion by a range of observers over several years during the mid-1980s, it is the most comprehensive nationwide survey of the dominant vegetation cover, condition and dune structure. Spinifex is widely scattered throughout most coastal regions of the North Island with only scattered patches from south Taranaki to lower Northland on the west coast and along the Wairarapa coast. Only scattered colonies of spinifex were found in the upper South Island. While some areas in both islands are rocky shore or cliffs, many sites are sand dunes where spinifex has been outcompeted by marram grass or struggled to survive other human-induced influences.

Overseas distribution

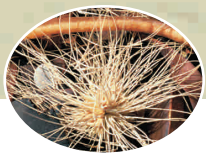
The same species of spinifex (*Spinifex sericeus*) is also native to parts of Australia and to New Caledonia (Beach Protection Authority of Queensland, 1981). The species in New Zealand (and eastern Australia) had previously been named *Spinifex hirsutus*. Many publications on the New Zealand flora list the New Zealand taxa as *S. hirsutus* but Connor (1984) showed that the New Zealand plants matched *S. sericeus*.

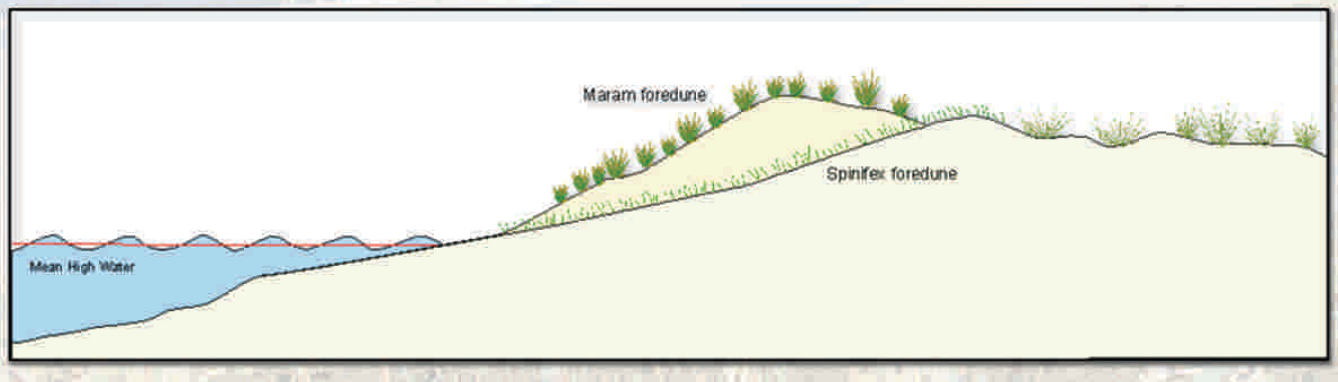
In Australia three coastal spinifex species and one hybrid are recognised, each located in different areas (Craig, 1984). *Spinifex sericeus* extends southwards from north Queensland, through New South Wales, Victoria, Tasmania, to near Adelaide in South Australia. *Spinifex hirsutus* is restricted to the south-west of Western Australia and *Spinifex longifolius* to northern Australia. *Spinifex alterniflorus*, a naturally occurring hybrid, is found where the distributions of *Spinifex hirsutus* and *Spinifex longifolius* overlap in Western Australia. A further species, *Spinifex littoreus*, is found along the east coast of Peninsula Malaysia.

HABITAT

Spinifex is an effective sand-binding plant that is dominant on the seaward face of foredunes. It is deep-rooting, thrives in raw sand, and is tolerant of salt spray, prolonged dryness, extreme temperatures, high light intensity, and strong wind (van Kraayenoord, 1986; Hesp, 1991). The upright shoots reduce surface wind velocity, resulting in sand deposition with frequent burial of the leaves and stems (Hesp, 1989; Beach Protection Authority of Queensland, 1981). Aggressive shoot growth then re-establishes the plant on the new sand surface, thereby building the dune. Where stands of spinifex are vigorous, runners will trail over recent erosion scarps caused by storms and high seas. These runners will encourage the build-up of wind-distributed sand along the scarp and eventually a return to a low-angle dune face typical of a spinifex-dominant dune.

Runners of spinifex trailing over a recent erosion scarp. These will take root and help the natural recovery of the foredune by trapping wind-blown sand.





Generalised profile of a foredune that occurs on the exposed west coast of the North Island where spinifex forms a low angle more regular seaward face due to its fast growing stolons. In contrast, where marram grass occurs on foredunes, a higher steeper dune is formed by the clumped upward growth habit of this sand binder (adapted from Esler, 1970).

Spinifex vs marram grass

On an exposed west coast site of the North Island Esler (1970) pointed out that spinifex on the foredune is a superior dune stabiliser than the introduced marram grass (*Ammophila arenaria*) because it has a greater tolerance of sea-water and provides an even cover of vegetation. Spinifex spreads freely downslope in all directions, and rapidly invades fresh sand deposits leading to the development of smaller, more regular dunes because of its fast-growing sprawling stolons. The seaward face of a spinifex foredune slopes very evenly at 14-16º up to a height of 6 m where it is frequently topped off with marram grass. Blow-outs do not occur within spinifex-dominated foredunes. There is a tendency for spinifex stolons to find concavities in the dunes and to gather sand thus filling incipient channels and moulding a more regular dune.

In contrast, marram grass occurs on the seaward side of the foredune to a small extent but does not thrive in the vulnerable gap just above the strand line that in colonised by spinifex and pingao. In the few places where marram grass occurs alone it often builds a dune that is higher (8 m or more) and steeper (24-28 º) than the spinifex dune. The clumped habit of marram grass causes irregular deposition of sand, forming high, hummocky, steep dunes that are vulnerable to severe erosion and blow outs.

In Australia where both species occur on foredunes, Davies (1980) also notes the morphological differences in foredunes formed by marram grass (hummocky ridges) compared to spinifex (low platforms).

Animal browsing

Grazing by cattle can retard establishment and growth of spinifex and lead to dune instability (Esler 1974). While spinifex appears to be less susceptible to browsing than pingao, it does get browsed by rabbits and domestic stock. Simpson (1974) suggests that grazing by rabbits and other animals in Canterbury may have contributed to its extinction from this region.

Regeneration and growth

Regeneration of spinifex from seed is not observed often along many New Zealand beaches even though it produces large quantities of seedheads every year which are widely distributed throughout the dune system by wind, and are trapped and covered by wind-blown sand. Of the natural germination that has been observed, it has occurred in spring once temperatures have increased.

Seedlings have taken several months to reach 15 cm high and are thus vulnerable to sand movement and disturbance from beach users.

Vegetative spread from existing colonies is the most common method for spinifex to spread naturally into bare areas. In New Zealand growth of stolons can exceed 5 m per year. Rapid growth of spinifex occurs during warmer seasons and where there is some sand accumulation. Growth of spinifex has been closely linked to temperature where there is a clear seasonal influence but there is also a boost in growth with sand burial (Hesp, 1982). In the warmer climates of Southeast Australia, although growth can take place throughout the year, maximum growth occurs in spring and summer months.

IMPORTANCE OF DUNE RESTORATION

Sand dunes along most parts of the coast of New Zealand have been highly modified since the time of earliest human settlement. In recent years, numerous programmes aimed at restoration of natural communities on sand dunes have been designed to meet a range of objectives including enhancing cultural, aesthetic and recreational values as well as conservation and biodiversity considerations.

Within its natural range, spinifex is the key indigenous sand binding plant for establishment and management along foredunes. Along with other indigenous sand binding species, particularly pingao, the Dune Restoration Trust of New Zealand has been investigating methods for large-scale establishment of spinifex for the rehabilitation of degraded foredunes on New Zealand beaches. Over the last decade, research trials and monitoring programmes have resulted in the development of practical methods for successful rehabilitation and management of dunes using spinifex that has led to widescale restoration of foredunes throughout New Zealand by managing agencies and local communities (Bergin and Kimberley, 1999; Bergin, 1999). Details on methods for restoration of dunes using spinifex are given in the Dunes Restoration Trust of New Zealand Technical Handbook Article No. 7.2

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