RESPONSE OF FOREDUNE VEGETATION TO APPLICATION OF FERTILISER ON SAND DUNES, BAY OF PLENTY

D. O. Bergin & M. O. Kimberley
***Forest Research*, Rotorua**

INTRODUCTION

Experience in Australia and from trials set up by ***Forest Research*** on two Coromandel beaches in the mid-1990s has indicated that fertiliser treatment of existing spinifex colonies is an efficient way of improving the vigour and extent of spinifex (Barr, Mason & Sultman 1983; Bergin & Herbert 1994). In October 1997, an operational-scale fertilising of the foredunes was undertaken along some 50 km of the Bay of Plenty coast by the local Coast Care groups in collaboration with Environment BOP and the local District Councils. Ten tonnes of urea was donated to the BOP Coast Care programme by the local fertiliser company Petrochem Ltd. The dunes along the beaches of Mount Maunganui, Omanu and Papamoa were fertilised by Coast Care groups but four sites were demarcated and left unfertilised during the operational programme. These sites were used to test a range of treatments with urea and provided an opportunity to evaluate the response of existing vegetation cover to fertiliser on a larger scale than was possible in the Coromandel trials. Detailed background and rationale for these trials as well as the trial design and initial assessments are given in a report to the 1998 CDVN Annual Meeting (Bergin, McGlone & Jenks 1998).

OBJECTIVES

- To monitor a range of rates and timings of application of urea fertiliser broadcast on a spinifex-dominated foredune.
- To determine a cost-effective and practical technique for large-scale application of urea fertiliser on sand dunes.
- To add results to the database and publish results in the form of guidelines for coastal managers interested in use of fertilisers to enhance existing foredune vegetation and to decrease dune erosion.

METHOD

Trial Sites

Four trial sites were established along the beaches of Mount Maunganui, Omanu and Papamoa. The sites are typical of most of the Bay of Plenty coastline which is characterised by a wide flat beach below mean high water mark and relatively low undulating backdunes. At the time the trial was established in October 1997, an erosion scarp up to 1.5 m high occurred along most parts of the beach where the toe of the foredune and vegetation has been removed by winter storms. Consequently, the fertilised zone is located immediately landward of the erosion scarp. This zone is mainly dominated by spinifex but significant colonies of pingao are present along the coast.

Trial Treatments and Design

Urea, a nitrogen based fertiliser, was used on all of the four sites. This was applied at different rates and times to test the effect of the various treatments. Two control plots were left unfertilised at each site.

The treatments applied to each plot for the four sites are shown in Appendix 1. The rates of application were: 100, 200, 400 and 800 kg N/ha. Single and split applications were tested for each rate. For the single application, all fertiliser was applied in spring 1997, and the other half in autumn 1998. The rate of fertiliser applied to each plot was calculated on the basis of N content of urea (46% N).

Each of the four sites or replicates consisted of 10 plots. Each plot was 10 m x 10 m and extended across the width of the natural dune. Treatment combinations for each plot were allocated randomly within each block (Appendix 1). The appropriate weight of fertiliser was applied to each plot by hand broadcasting fertiliser from a bucket to give an even spread throughout each plot.

Monitoring of Vegetation

In order to quantify the effect of fertiliser on vegetation, post-treatment vegetation cover was assessed using a point sampling frequency technique (Bergin, McGlone & Jenks 1998). The first assessment was carried out early February 1998 prior to the autumn fertiliser treatment, and a second assessment was carried out in February 1999. A list of names of plants found during the assessments is given in Appendix 2.

RESULTS

Vegetation cover

The first assessment indicated that average total vegetation cover on non-fertilised sand dune plots was relatively high at 62% (Bergin, McGlone & Jenks 1998). These control plots were covered in nearly 40% of spinifex, 8% sand convolvulus (*Calystegia soldanella*), and 6% pingao (*Desmoschoenus spiralis*). Herbaceous exotic weed species made up most of the remaining vegetation at all sites but all at relatively low levels of cover.

At the second assessment 10 and 16 months after application of fertiliser, total vegetation cover on non-fertilised plots was 51.5% (Table 1). Spinifex remained the dominant cover at nearly 37% with 4 % of sand convolvulus and 3% of pingao. Other indigenous species and weeds were at relatively low levels.

Response to fertiliser

Within four months of the initial fertiliser application, there was a significant boost to vegetation cover where 200 kgN/ha or more had been applied (Fig. 1). There was no response in growth to fertiliser for other species including weed cover.

The second assessment carried out almost a year after the first fertiliser application showed a significant increase in growth of spinifex to application of fertiliser at the 100 kgN/ha rate and this trend continued up to and including the 400 kgN/ha rate (Table 1; Fig. 2). Although total vegetation cover increased steadily from 51% with no fertiliser to nearly 80% cover where 800 kgN/ha had been applied, most of the increase in cover was attributed to the spinifex component which increased from 37% in non-fertilised control plots to over 70% where fertiliser had been applied. As with the 4-month assessment, there was no significant increase

Table 1: ***Percentage cover by species averaged across all four trial sites for the range of fertiliser treatments, February 1999. Urea fertiliser was applied at rates from 100 to 800 kg N/ha in single and split applications in October 1997 and February 1998. Code indicates broad grouping of the species (other than spinifex) as follows: W - weeds, mainly exotic herbaceous weeds and grasses, O - other species, mainly indigenous species and a woody exotic species.***

Code	Species	Fertiliser application rate (kg N/ha)				
		0	**100**	**200**	**400**	**800**
	Spinifex sericeus	36.9	50.4	54.1	63.9	71.2
O	*Calystegia soldanella*	3.9	4.5	4.9	3.1	4.5
W	*Taraxacum officinale*	2.3	1.1	1.5	1.0	0
O	*Lupinus arboreus*	0.9	0.1	0.2	0.9	0.9
W	*Lagurus ovatus*	1.1	1.1	0.7	0.6	0.3
W	*Gazania rigens*	0.1	0	0.2	0.1	0.2
W	*Lachnagrostis filiformis*	0	0.1	1.1	0	0.8
W	*Senecio skirrhodon*	0.7	0.4	0.3	0.1	0
W	*Carpobrotus edulis*	0.4	1.1	5.7	2.4	0.1
W	*Cakile maritima*	0	0	0	0	0.1
O	*Muehlenbeckia complexa*	0.8	1.1	0.1	1.4	0.2
O	*Isolepis nodosa*	0	0.4	0	0	0
O	*Desmoschoenus spiralis*	2.9	6.4	8.8	10.0	1.1
O	*Deyeuxia billardieri*	1.2	0.3	0.2	0.3	0
W	*Holcus lanatus*	0	0.1	0.1	0.1	0.1
O	*Pittosporum crassifolium*	0.1	1	1	1	1
W	*Oxalis corniculata*	0.2	0	0	0.1	0
W	*Orobanche minor*	0	0.1	0	0	0
	Total vegetation cover	**51.5**	**67.2**	**77.1**	**85.8**	**79.5**

in weeds or other indigenous species with application of fertiliser. There was no significant difference between single and split applications at any rate of fertiliser application.

DISCUSSION

There was clearly an early boost to new growth of spinifex within four months of application of urea fertiliser at the higher rates tested. Inspection of fertilised sites within a few weeks of fertiliser application showed a greener spinifex cover compared to the light brown colour of spinifex in unfertilised plots. Although the lower rate of 100 kgN/ha did not show a significant boost to growth in the first assessment, 4 months after application, the following assessment 10 to 16 months after application did indicate a significant increase in spinifex cover.

Of interest is the lack of response of spinifex cover to the lowest rates of fertiliser 4 months after application of fertiliser. A minimum of 200 kg N/ha was required to boost growth at this early stage (Fig. 1). The BOP operational-scale fertilising programme carried out at the same time that the trials were established aimed to broadcast approximately 50 kg N/ha in spring and a repeat application of 50 kg N/ha in autumn. Preliminary assessment of spinifex cover suggests that a greater rate of fertiliser than 50 kg N/ha should be applied if the aim is to ensure an immediate boost in spinifex cover.

It took time for the impact of the larger rates of fertiliser to boost spinifex cover. By the second assessment, there was a significant increase in spinifex growth at the 200 and 400 kgN/ha levels but no additional benefit in applying the largest rate of 800 kgN/ha. Results indicate that the most effective fertilising strategy for giving an immediate boost to growth is to apply a minimum of 200 kgN/ha of urea to the foredune. For a maximum boost in vegetation cover, an application of up to 400 kgN/ha is required. However, application rates above this level are not likely to give additional benefit. Australian studies have given similar results and recommendations based on extensive fertiliser trials with spinifex (Barr, Mason & Sultman 1983; McKenzie, Mason & Sultman 1989).

As with the Coromandel fertiliser trials, fertilising dunes with fast-release fertilisers do not significantly increase the weediness of the site (Bergin & Herbert 1997). Fertiliser in fact increases the cover of spinifex probably due to the taller stature of the plant compared many of the exotic herbaceous and grass species present.

FUTURE RESEARCH DIRECTION

With the current Mount Maunganui Beach-Papamoa Beach fertiliser trial, several aspects of research will require continuing and, where possible, further investigation. These include:

- Monitoring the response of vegetation cover to application of fertiliser for at least a further year to determine the most effective technique for fertilising degraded dunes.
- Producing guidelines for coastal managers interested in using fertilisers on foredunes to assist in improving vegetation cover and improving dune erosion.
- Comparing seedhead production and proportion of formed seed in large blocks of fertilised and unfertilised foredune.
- Determining the effect of fertiliser on both above and below ground plant biomass.
- Determining the pathway of nutrients in both dune vegetation and substrate after application of fertiliser.

The monitoring of the existing trials will continue for a further year with funding from the Coastal Dune Vegetation Network (CDVN) for 1999/2000. This will include publishing guidelines on fertilising dunes which will be incorporated into the next CDVN Technical Bulletin on spinifex. The other research projects on seedhead production, biomass, and nutrition studies are part of the long term ***Forest Research*** Sand Dune Research Programme funded by the Foundation for Research, Science and Technology.

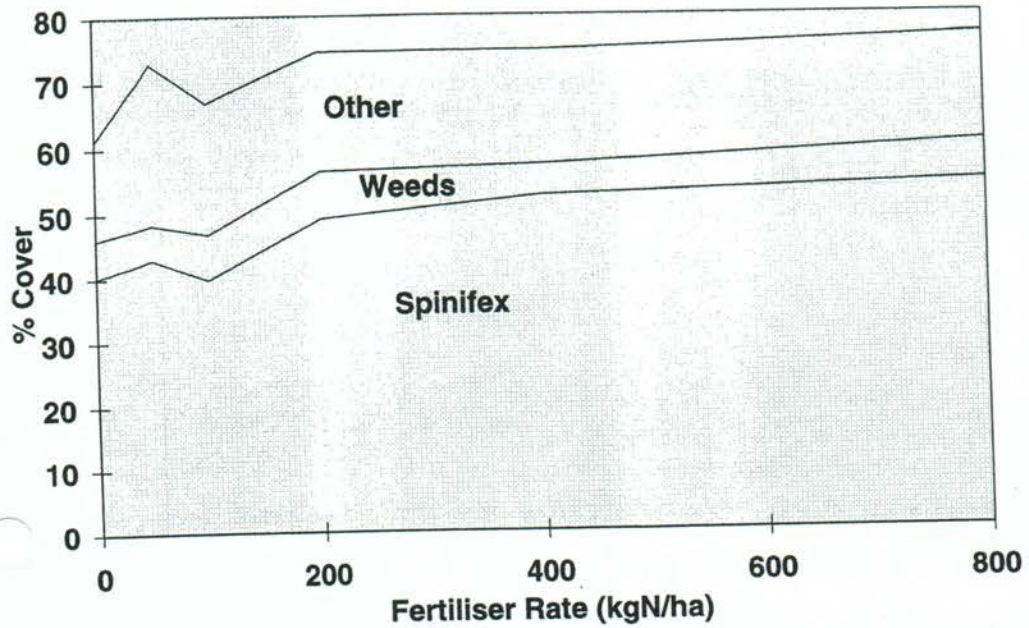

Figure 1: Percentage cover by spinifex and plant groups averaged across all four trial sites for the range of fertiliser treatments within the first 6 months of application of fertiliser. Urea fertiliser was applied at rates from 50 to 800 kg N/ha in one application in mid-October 1997. Refer to Table 2 for broad groupings of weed (W) and other (O) categories.

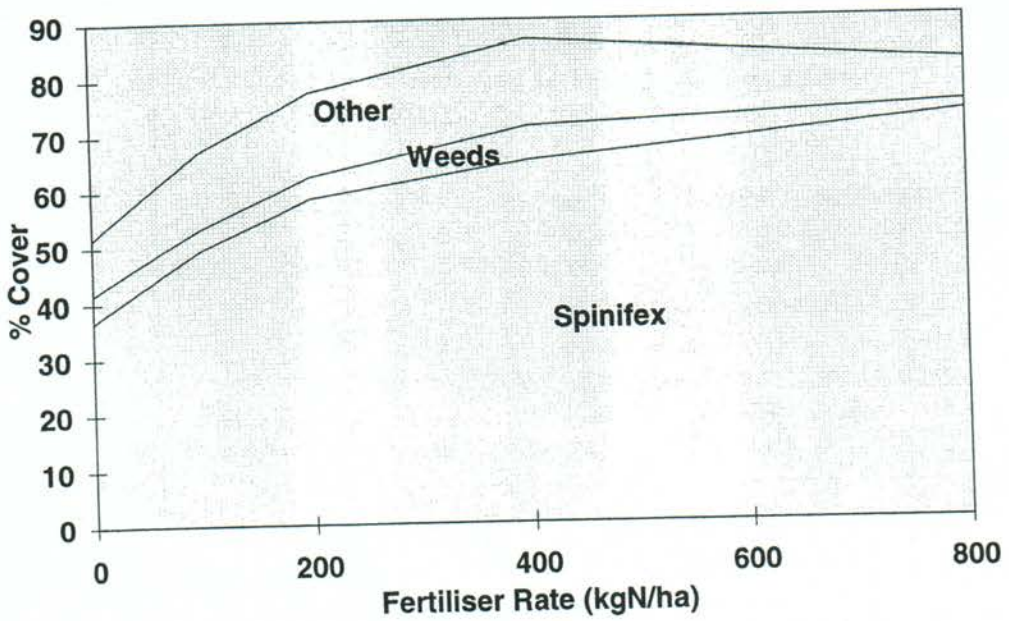

Figure 2: Percentage cover by spinifex and plant groups averaged across all four trial sites for the range of fertiliser treatments 12-18 months after of application of fertiliser. Urea fertiliser was applied at rates from 50 to 800 kg N/ha in single and split applications in October 1997 and February 1998. Refer to Table 2 for broad groupings of weed (W) and other (O) categories.

ACKNOWLEDGEMENTS

Fiona Ede and Helena Beeser assisted with establishment of the trial including application of fertiliser. Jeremy Cox, Heidi McGlone and Jessamy Herbert assisted with assessment of vegetation cover. Petrochem Ltd, part of the BOP Fertiliser group of companies, kindly supplied the urea fertiliser for the trials as well as the operational-scale fertilising of the foredunes from Waihi Beach through to the eastern beaches of Opotiki, a total treated area of 50 km.

REFERENCES

Barr, D. A. & McDonald, T. J. 1980: The effect of nitrogenous and phosphatic fertilisers on the growth of sand spinifex grass (Spinifex hirsutus). Pp. 22-32 *in* Beach Protection Authority of Queensland. Dune Stabilisation and Management Research Programme. Report Number D 01.4.

Barr, D. A.; Mason, B. J. & Sultman, S. D. 1983: The effect of combinations of urea and superphosphate on the growth of sand spinifex grass (Spinifex hirsutus). Pp. 62-73 *in* Beach Protection Authority of Queensland. Dune Stabilisation and Management Research Programme. Report Number D 02.1.

Bergin, D. O.; Herbert, J. W. 1994: Establishment of spinifex fertiliser trials, Matarangi Beach and Whiritoa Beach, Coromandel. New Zealand Forest Research Institute, Rotorua. (Unpubl.). 9p.

Bergin, D. O. & Herbert, J. W. 1997: Revegetation of sand dunes in New Zealand using indigenous species. Proceeding of *Pacific Coasts and Ports '97 Conference*, 7-11 September 1997, Christchurch. Vol. 1: 425-30.

Bergin, D. O.; McGlone, H. M.; Jenks, G. 1998: Establishment of a fertiliser trial on sand dunes, Mount Maunganui, Omanu and Papamoa beaches, Bay of Plenty. *In* Coastal Dune Vegetation Network Annual General Meeting and Field Trip 12-13 March 1998. Compilers G. A,. Steward & F. J. Ede. ***Forest Research***, (Unpubl.). 13-23.

McKenzie, J. B.; Mason, B. J.; Sultmann, S. D. 1989: Fertilising strategy for sand spinifex grass (*Spinifex sericeus*). Pp. 73-86 *in* Beach Protection Authority of Queensland. Dune Stabilisation and Management Research Programme. Report Number D 02.28.

APPENDIX 1 - Fertiliser treatments for plots at the four sites located along Mount Maunganui and Papamoa Beaches, Bay of Plenty.

Plot No.	Site No.	Fertiliser Type	Fertiliser Rate (kg/ha)	Timing of application *	Fertiliser applied to each plot ** (kg)
1	1	Control			
2	1	Urea	400	single	8.696
3	1	Urea	400/400	split	8.696
4	1	Urea	50/50	split	1.087
5	1	Urea	100	single	2.174
6	1	Urea	400	single	8.696
7	1	Control			
8	1	Urea	200	single	4.348
9	1	Urea	800	single	17.392
10	1	Urea	100/100	split	2.174
1	2	Urea	200	single	4.348
2	2	Urea	400	single	8.696
3	2	Control			
4	2	Urea	800	single	17.392
5	2	Urea	50/50	split	1.087
6	2	Urea	400/400	split	8.696
7	2	Urea	100/100	split	2.174
8	2	Urea	100	single	2.174
9	2	Urea	200/200	split	4.348
10	2	Control			
1	3	Urea	50/50	split	1.087
2	3	Urea	400	single	8.696
3	3	Urea	200	single	4.348
4	3	Urea	100/100	split	2.174
5	3	Control			
6	3	Urea	100	single	2.174
7	3	Urea	200/200	split	4.348
8	3	Control			
9	3	Urea	800	single	17.392
10	3	Urea	400/800	split	8.696
1	4	Urea	100/100	split	2.174
2	4	Urea	400/400	split	8.696
3	4	Urea	100	single	2.174
4	4	Urea	400	single	8.696
5	4	Control			
6	4	Urea	200/200	split	4.348
7	4	Urea	50/50	split	1.087
8	4	Urea	800	single	17.392
9	4	Control			
10	4	Urea	200	single	4.348

* Timing of fertiliser application - for single applications, all fertiliser was applied in Spring (October 1997); for split applications half rate was applied in Spring (October 1997) with the remainder applied in Summer (February 1998).

**Indicates the actual amount of fertiliser applied to each plot in spring and summer where appropriate.

APPENDIX 2 - List of plant species found in the fertiliser trial plots, Mount Maunganui and Papamoa Beaches, Bay of Plenty.

Botanical name	Common or Maori name	Brief plant description
Spinifex sericeus	spinifex	indigenous sand binding grass
Calystegia soldanella	sand convolvulus	indigenous sand dune creeper
Taraxacum officinale	dandelion	exotic herb common on stable dunes
Lupinus arboreus	yellow tree lupin	exotic woody shrub
Lagurus ovatus	harestail	exotic grass common on dunes
Gazania rigens	livingstone daisy	exotic herbaceous ground cover
Lachnagrostis filiformis		exotic grass
Senecio skirrhodon	gravel groundsel	exotic herb
Carpobrotus edulis	ice plant	exotic succulent ground cover
Cakile maritima	sea rocket	exotic herb often just above high tide level
Pittosporum crassifolium	karo	indigenous shrub
Muehlenbeckia complexa	pohuehue	indigenous woody ground cover
Osteospermum fruticosum		exotic herb
Oxalis corniculata	horned oxalis	exotic herb
Holcus lanatus	Yorkshire fog	exotic grass
Orobanche minor	broomrape	exotic parasitic herb
Isolepis nodosa	knobby club rush	indigenous rush
Desmoschoenus spiralis	pingao	indigenous sand binding sedge