Fields 800 Sand Trial Results

Introduction

At the request of McCallum Brothers Ltd, NZ Sports Turf Institute has been undertaking a trial to test the suitability of marine sourced sand (Fields 800) for use in the construction of sand based sports fields. The trial aims to compare the growth characteristics of three commonly used turf grasses (ryegrass, *Cynodon* and kikuyu) when grown in the Fields 800 sand with the same species grown in a proven 'industry standard' sand (control). The trial was established in January 2007 at NZSTI research plots in Palmerston North and has been running for 18 months.

Fields 800 sand contains approximately five percent biogenic shell material, and has an elevated $pH_{(water)}$ and a high concentration of available (exchangeable) calcium. The concern was that the elevated pH will promote worm activity thereby, increasing the rate of contamination when used in a sand carpet sports field and shortening the expected 'life' of the field. A high concentration of available calcium may induce foliar deficiencies of other nutrients, mainly magnesium and potassium.

The Fields 800 sand used in the trial had a particle size distribution which sits within accepted limits for sports field applications. Calcium carbonate content was found to be approximately 5 percent. Tests on other samples of Fields 800 sand have shown the hydraulic conductivity to be approximately 600mm/hr. This was considerably above the accepted minimum of 300mm/hr for sports field applications.

Materials and methods

The trial consists of a 50mm sand carpet over a silt loam sub-soil. It was set up using a randomised design consisting of three main plots of each sand. Each main sand plot was further divided into three sub-plots with the grasses randomly allocated to the sub-plots, such that each main sand plot contains one sub-plot of each turf grass. Plot sizes are 3m x1m, with a total trial area of $54m^2$. The ryegrass was sown at $4kg/100m^2$ and *Cynodon* and kikuyu stolons were applied at a rate of at least $6kg/100m^2$.

Maintenance of the trial included up to weekly mowing at heights of 30mm for the ryegrass and kikuyu plots and 15mm for the *Cynondon* plots. The trial received a basal dressing of slow release fertiliser prior to establishment. A further seven applications per year of nitrogen fertiliser were applied to the ryegrass plots to give 150kg N/ha per year. Five applications per year of nitrogen fertiliser were applied to the kikuyu and *Cynodon* plots to give 110 kg N/ha per year. Weeds were not controlled apart from a one-off spot application of glyphosate to weeds in the *Cynodon* plots in the first winter of the trial. No fungicides or pesticides were used to control disease or insect pests.

Plots have been scored for early establishment density and total sward density, which includes an assessment of total ground cover including both the desirable turf grass plus any weeds present. Sward density was scored on a 1-9 scale (9 = best; 1 = worst). Plots were assessed for percentage of weed cover and earth worm activity by counting the number of surface casts present on a monthly basis during winter and early spring. The degree of sand contamination (sand contamination severity index) was also assessed 18 months after establishment using the settlement test.

Sand (0-50mm) and soil samples (50-100mm) were collected and analysed for pH, Olsen P and exchangeable cations at the start of the trial, and again at four, ten and 18 months after establishment. Foliar samples were also collected and analysed for percentage nitrogen, phosphorus, sulphur, calcium, magnesium, potassium and sodium plus trace elements at two months and 12 months after establishment.

Figure 1: Trial three weeks after establishment

Results

Early establishment

Plots were scored for early establishment density at approximately fortnightly intervals from week's six to ten after establishment. By 10 weeks after establishment, early establishment density scores were all in the range 9 to 5.7 (Table1). There were no significant differences in the establishment densities of the grasses between the two sands. The *Cynodon* plots were slowest to establish and had not reached full cover at 10 weeks.

Table 1: *Early establishment density*

Sand	**Species**	**Sward density 10 weeks after sowing**
Fields 800	Ryegrass	9
Control	Ryegrass	8.3
Fields 800	*Cynodon*	6.7
Control	*Cynodon*	5.7
Fields 800	Kikuyu	7.3
Control	Kikuyu	7.3
Significance		ns

Sward density

Sward density was scored at approximately fortnightly intervals from weeks 10 to 18 after establishment and then at monthly intervals. Sward density scores were grouped on a seasonal basis and only a seasonal mean score is reported here. No significant differences were recorded in sward density for the individual grasses between the Fields 800 and control sands (Table 2). Generally, sward densities for the *Cynodon* and kikuyu declined over the winter period, whereas the ryegrass plots were at their lowest densities during summer dry periods.

Table 2: *Sward density*

		Sward density					
Sand	**Species**	**Autumn 07**	**Winter 07**	**Spring 07**	**Summer 07**	**Autumn 08**	**Winter 08**
Fields 800	Ryegrass	9.0	9.0	8.8	8.0	8.7	8
Control	Ryegrass	9.0	9.0	8.7	7.9	8.7	8
Fields 800	*Cynodon*	7.4	8.9	6.5	6.3	9.0	8.7
Control	*Cynodon*	7.1	8.8	6.8	6.9	9.0	8.6
Fields 800	Kikuyu	8.3	8.6	7.7	8.2	9.0	7.9
Control	Kikuyu	8.1	9.0	8.3	8.4	9.0	8.2
Significance		ns	ns	ns	ns	ns	ns

Figure 2: Trial fully established

Percentage weed cover

The percentage weed cover per plot was assessed at least once per season. There were no significant differences in the amount of weed infestation between the Fields 800 and control sands (Table 3). Due to the slow grow-in of the *Cynodon* plots they suffered from a considerable infestation of weeds in the first autumn and winter. Similarly, the kikuyu plots also suffered from weed infestations in the spring following the period of winter dormancy.

Table 3: *Percentage weed cover*

Sand	Species	Weed cover					
		Autumn 07	**Winter 07**	**Spring 07**	**Summer 07**	**Autumn 08**	**Winter 08**
Fields 800	Ryegrass	0.7	0.0	0.0	9.0	14.3	22.1
Control	Ryegrass	1.3	0.0	12.7	10.0	11.0	16.4
Fields 800	*Cynodon*	62.3	51.3	8.7	5.3	5.3	9.3
Control	*Cynodon*	58.7	52.3	8.7	12.3	12.3	13.7
Fields 800	Kikuyu	17.7	17.0	56.7	3.0	8.3	13.6
Control	Kikuyu	16.0	14.7	27.0	4.7	6.0	8.8
Significance		ns	ns	ns	ns	ns	ns

Worm surface casts and sand contamination severity

Counts of earthworm surface casts showed no significant differences in the level of activity between the Fields 800 and control sands (Table 4). Generally, more surface cast were observed on the surface of the ryegrass plots compared to the *Cynodon* and kikuyu plots.

There was no significant difference in the contamination severity index between the Fields 800 and control sands (Table 4). The level of contamination recorded for both sands across the three grasses can be interpreted as the sand being relatively clean. The results of the contamination severity index for the *Cynodon* and the kikuyu plots indicates that the earthworms were able to deposit a portion of their casts within the layers of stolons rather than coming completely to the surface as observed in the ryegrass.

Table 4: *Worm surface cast counts and sand contamination severity index*

Sand	Species	Worm casts			Contamination severity index
		Winter 07	**Spring 07**	**Winter 08**	**(%)**
Fields 800	Ryegrass	63.2	25.0	49.9	11.3
Control	Ryegrass	42.2	15.0	40.6	11.6
Fields 800	*Cynodon*	20.7	14.3	12.6	14.9
Control	*Cynodon*	20.2	8.3	5.3	9.8
Fields 800	Kikuyu	20.4	13.8	12.1	15.3
Control	Kikuyu	17.7	9.5	6.4	8.1
Significance		ns	ns		ns

Foliar nutrient analysis

Foliar samples were taken 2 months and 12 months after establishment for nutrient analysis. Only nitrogen was below desirable levels for adequate grass growth and this was common to both sands at both times of sampling (Table 5). Concentrations of foliar P in the samples collected at 2 months were significantly higher (averaged across all grass types) in the grasses grown in the control sand, compared to the grasses in the Fields 800. Also in the samples collected at 2 months, concentrations of foliar Ca were significantly higher in the grasses grown in the Fields 800 sand, compared to the grasses grown in the control sand.

However, by 12 month sampling no significant differences were recorded in foliar concentrations of nutrients analysed. To date, the high concentrations of available calcium in the Fields 800 sand have not induced any foliar deficiencies of other nutrients.

Table 5: *Foliar analysis 2 and 12 months after establishment*

		2 months						12 months					
		N	**P**	**K**	**S**	**Ca**	**Mg**	**N**	**P**	**K**	**S**	**Ca**	**Mg**
Sand	**Species**	%	%	%	%	%	%	%	%	%	%	%	%
Fields 800	Ryegrass	4.0	0.63	2.6	0.34	0.67	0.23	2.6	0.29	1.8	0.32	0.88	0.21
Control	Ryegrass	3.6	0.78	2.3	0.30	0.43	0.25	2.4	0.25	1.6	0.32	0.59	0.19
Fields 800	*Cynodon*	3.6	0.49	1.6	0.34	0.80	0.27	1.8	0.22	1.1	0.29	0.93	0.13
Control	*Cynodon*	3.3	0.51	1.5	0.33	0.58	0.20	2.0	0.26	1.3	0.34	0.34	0.12
Fields 800	Kikuyu	3.1	0.40	1.8	0.25	0.85	0.28	2.3	0.31	2.1	0.20	0.41	0.16
Control	Kikuyu	3.2	0.60	2.8	0.25	0.32	0.27	2.3	0.32	2.0	0.20	0.36	0.17
Significance		ns	0.002	ns	ns	0.0001	ns	ns	ns	ns	ns	ns	ns
CV%			23.4			35.5							
LSD 5% level			0.07			0.13							

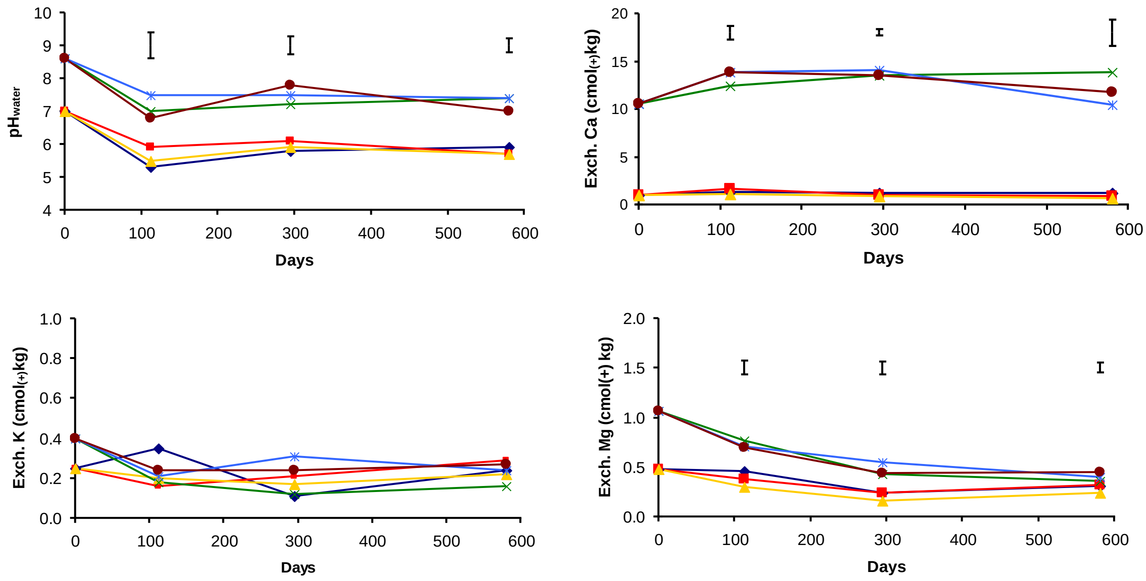
Sand nutrient analysis

Comparing results from analysis of sand samples collected at 18 months with those collected at the start of the trial, mean soil pH in the Fields 800 plots decreased from pH 8.6 to 7.3 (Figure 3). In sand samples from the control plots soil pH has also decreased from pH 7 to 5.8. The soil pH of the Fields 800 sand was significantly higher than the pH in the control sand at each sampling time after establishment.

Mean exchangeable Ca concentrations of the sand in the Fields 800 plots increased from 10.5 to 12 $cmol_{(+)}kg$, indicating some decomposition of the shell material. Exchangeable Ca concentrations were significantly higher in the Field 800 sand compared to the control sand at each sampling time after establishment.

In the Fields 800 plots mean exchangeable K concentrations of the sand in the Fields 800 plots decreased from 0.4 to 0.26 $cmol_{(+)}kg$. By contrast, there were no changes in mean concentrations of exchangeable Ca and K sand samples collected from the control plots.

In the Fields 800 plots mean exchangeable Mg of the sand decreased from 1.06 to 0.4 $cmol_{(+)}kg$ and exchangeable Na has decreased from 2.12 to 0.12 $cmol_{(+)}kg$. Similarly, in the control plots mean exchangeable Mg of the sand has decreased from 0.48 to 0.29 $cmol_{(+)}kg$ and mean exchangeable Na has decreased from 0.16 to 0.10 $cmol_{(+)}kg$. Exchangeable Mg concentrations in the Fields 800 plots were significantly higher compared to the control sand at each sampling time after establishment.



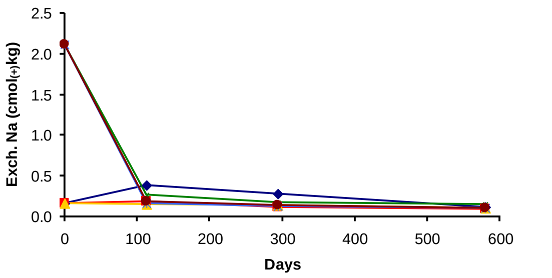


Figure 3: Changes in soil pH, and concentrations of exchangeable Ca, K, Mg and Na with time in the Fields 800 and control sands (0-50mm) for each grass species: **x** :Fields 800 Ryegrass, ● :Fields 800 *Cynodon*, ✳ :Fields 800 Kikuyu, ♦ :Control Ryegrass, ▲ : Control *Cynodon*, ■ :Control Kikuyu; Vertical bars indicate l.s.d. ($P = 0.05$)

Subsoil nutrient analysis

Comparing results from analysis of subsoil (50-100mm) samples collected at 18 months with those collected at the start of the trial, mean subsoil pH in the Fields 800 plots increased from pH 5.3 to 6.8 (Figure 4). In the control plots subsoil pH increased from 5.3 to 5.6. The subsoil pH values of the Fields 800 plots were significantly higher than the subsoil pH of the control plots at each sampling time after establishment.

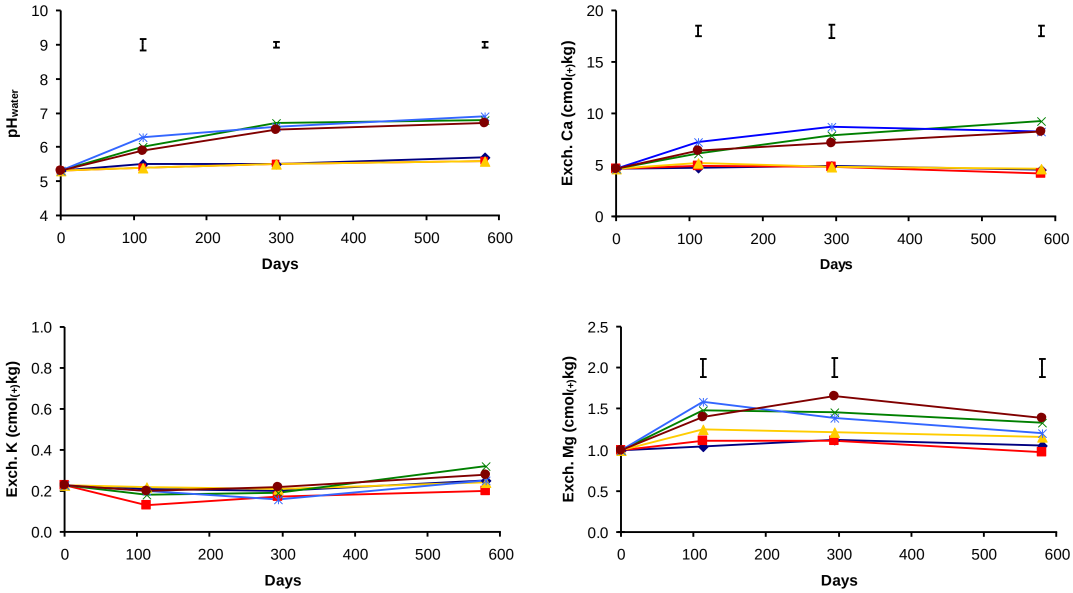
Mean exchangeable Ca concentrations in the subsoil of the Fields 800 plots increased from 4.6 to 8.6 $cmol_{(+)}kg$. By contrast mean exchangeable Ca concentrations in the subsoil of the control plots decreased from 4.6 to 4.3 $cmol_{(+)}kg$. Exchangeable Ca concentrations were significantly higher under the Fields 800 sand compared to those recorded under the control sand plots at each sampling time after establishment.

In the subsoil of the Fields 800 plots, mean exchangeable K concentrations increased from 0.23 to 0.28 $cmol_{(+)}kg$, whereas, there was no change in mean exchangeable K concentrations in the subsoil of the control plots.

Mean concentrations of exchangeable Mg in the subsoil of the Fields 800 plots increased from 0.99 to 1.31 $cmol_{(+)}kg$. Similarly, in the control plots mean exchangeable Mg of the subsoil has increased from 0.99 to 1.06 $cmol_{(+)}kg$. As with exchangeable Ca, concentrations of exchangeable Mg in the subsoil of the Fields 800 plots were significantly higher compared to the control plots at each sampling time since establishment.

Mean concentrations of exchangeable Na have increased from 0.11 to 0.16 $cmol_{(+)}kg$ in the subsoils of both the Fields 800 and the control plots. However, there was a significant flush of exchangeable Na, in the subsoil of the Fields 800 subsoil compared to the control plots, recorded at four and ten months after establishment.

These results indicate that leaching of cations, particularly calcium, from the Field 800 sand has taken place. It should be noted that the trial has largely been fertilised with acidifying nitrogen fertilisers.



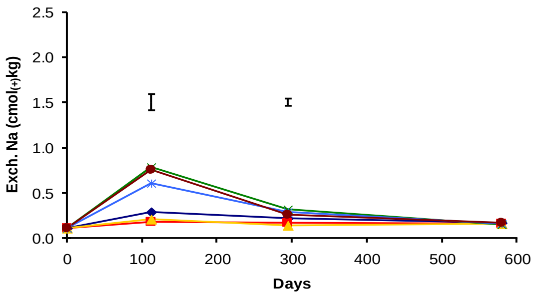


Figure 4: Changes in soil pH, and concentrations of exchangeable Ca, K, Mg and Na in the subsoil (50-100mm) under the Fields 800 and control sands for each grass species: **x** :Fields 800 Ryegrass, ● :Fields 800 *Cynodon*, ✳ :Fields 800 Kikuyu, ♦ :Control Ryegrass, ▲ : Control *Cynodon*, ■ :Control Kikuyu; Vertical bars indicate l.s.d. ($P = 0.05$)

Conclusion

In the 18 months since establishment there have been no differences in the growth characteristics of the three grasses between the two sands used in the trial. The elevated concentrations of exchangeable calcium in the Fields 800 sand have not resulted in any induced deficiencies of other nutrient. Elevated soil pH has not resulted in any significant increases in worm activity or increases in contamination of the Fields 800 sand.

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