

Performance of fodder beet cultivars in the South Island

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Abstract

More than 11 cultivars of fodder beet are marketed to farmers, but with little refereed data on differences in potential yield. Trials were established in spring 2012 to evaluate the yield, dry matter content of bulbs, and proportion out of the ground of 13 beet cultivars, at four sites in the South Island. There were differences between cultivars for yield, field emergence, dry matter percentage (DM%) of the bulb, and percentage of the bulb out of the ground. The cultivars 'Enermax' (19.37 t dry matter/ha), 'Magnum' (18.98), 'Bangor' (17.83), 'Troya' (17.54) and 'Kyros' (17.39) were more productive than 'Brigadier' (14.00), which was similar to 'Feldherr' (15.15). There were no interactions between cultivar performance and site. These trials prove that the selection of cultivar has a large effect on the yield and profitability of fodder beet crops.

Keywords: Fodder beet, *Beta vulgaris*, yield, dry matter, cultivars, fertiliser, disease.

Introduction

Fodder beet (*Beta vulgaris*) is now a commonly grown forage crop in New Zealand, with an estimated total area of over 16 000 hectares planted in 2013 (KPMG 2014). The increase in popularity is due to the high yields (20–40 tonnes dry matter (DM)/hectare) being achieved, high feed value (12–14 MJME/kg DM), flexibility of when it can be grazed (March to November), and ability to grow in soil contaminated with brassica diseases.

High crop yields have been achieved on farms, with some measured at ≥ 40 tonnes DM/hectare, but average yields of 20–25 tonnes are more typical in the South Island. The range between average and top yields can be due to differences in plant population, fertiliser use, rainfall, sowing date, and temperature over the growing period. Feed value and utilisation rates are high (Gibbs 2013). Near infrared spectroscopy measurements often measure 14.5 MJME/kg DM in the bulb (Matthew *et al.* 2011), but these may not be entirely accurate because of a relative lack of calibration for this crop, and some suggest lower levels of 12 MJME/kg DM are more realistic (Gibbs 2013).

The crop can be more economic than alternatives, with feed produced for 7–12 cents per kg of DM

(Gibbs 2013), depending on yield and costs, while Kale typically produces feed for 8–12 cents per kg. Furthermore, the higher utilisation rates (95 vs 85%) and feed value (12–12.5 vs 11–12.5 MJME/kg DM (DairyNZ 2013)) of fodder beet compared with kale make the crop even more profitable than the DM production alone would indicate.

More than 11 cultivars of fodder beet were sold in New Zealand in 2013, with differences stated in marketing material in dry matter content, yields, suitability to stock classes, ability to be harvested, storability, seed type, palatability, disease tolerance, utilisation and percentage of bulb out of the ground (Seed Force 2014). In the 1920s in New Zealand beets were the mangel types (open pollinated, multi-germ seed with low DM% bulbs), with over 2500 hectares grown (Claridge 1972). In the last half of the 20th century hybrid mono-germ cultivars were developed and are now the most commonly used in Europe (V. Meyer 2013 pers. comm.). Hybrid mono-germ cultivars were favoured because single seeds are produced and require less processing, resulting in better plant establishment and yields.

Another major difference between cultivars that would be expected is yield potential, as a result of the development of hybrid breeding methods, and many years of plant selection and breeding.

The objective of these trials was to compare the yield, dry matter percentage of the bulb, field emergence, and percentage of bulb out of the ground, of 13 cultivars of beet across four sites in the South Island.

Methods

Sites

Four sites were located within commercial fodder beet crops in the South Island. Two sites were irrigated (Canterbury and North Otago) and two were rain-fed. The Canterbury site (43°58'09.77"S, 171°55'59.24" E) was 15 km south-east of Ashburton on a Lismore soil with centre-pivot irrigation. The North Otago site (44°54'19.37"S, 170°47'04.83"E) was 29 km north-west of Oamaru on yellow grey earth soils, typical of the downlands, with centre-pivot irrigation. The South Otago site (46°05'33.78"S, 169°32'48.59" E) was 23 km north-west of Balclutha on a shallow soil overlying

dense rock. The Southland site (46°9'0"S, 168°20'0" E) was 3 km north-west of Winton on alluvial Oreti soils.

Establishment

Site preparation (fertiliser, cultivation) was the same as for the rest of the paddock the trials were located within. Trials were planted on the same day as the rest of the paddock – Canterbury on 12 October 2012, South Otago on 24 October 2012, North Otago on 27 October 2012, and Southland on 14 November 2012. Seed was drilled with the precision drill used for the commercial crop at each site, at 90 000 seeds/ha, except for Southland (80 000), and all at 50 centimetre row spacing. Each plot was 15 metres long, and three rows of each cultivar were drilled in four randomised complete blocks.

Each site received the same management inputs as the rest of the paddock, including herbicides, insecticides, and fertiliser, with “best-practice” husbandry applied in all sites.

Treatments

Twelve fodder beet cultivars and one sugar beet cultivar were tested (Table 1). Seven of the cultivars were established at all four sites, with the remaining treatments on either two or three of the sites, due to availability of seed and time of sowing, and dimensions of drills.

Measurement

The number of plants established per square metre was counted 4–6 weeks after planting, by counting all plants in

the three 15 m rows for each cultivar in each replication. Results are presented as relative field emergence, where 100 is the mean plant number for the site.

Cultivars were assessed for tolerance to leaf diseases on 26 March 2013 at South Otago and Southland, on 2 April 2013 at North Otago, and on 11 April 2013 at Canterbury. A scale of 1 to 9 was used, where 9 represented no sign of disease and 1 represented severe infection.

Fodder beet was harvested in autumn. The final harvest dates were 14 May 2013 in Canterbury (214 days after sowing (DAS)); 20 May 2013 in North Otago (205 DAS); 5 June 2013 in South Otago (224 DAS); and 4 June 2013 in Southland (202 DAS).

A common row length (10 m) was measured and all plants from the centre row of each treatment were harvested. Tops (leaf and stem) were separated from bulb and bulbs divided at ground level and separated into above and below ground components, and the three components weighed separately. Bulbs were scraped of soil. Dry matter content of bulbs was measured with sub-samples (four bulbs of average size for each row) dried in ovens (fan-forced oven, 110°C for 48 hours), and a standard DM content of 10% was assumed for tops because previous tests showed no variation between cultivar.

The feed quality of bulbs from all cultivars in one replication at the South Otago site was assessed by Hill Laboratories, Christchurch, to determine if full testing was warranted. Differences were negligible, so further analysis was not conducted.

Utilisation was assessed after grazing of each site

Table 1 Mean yield (t DM/ha) of 13 fodder beet cultivars at four sites in the South Island

Cultivar	Mean of four sites	Canterbury	North Otago	South Otago	Southland
Enermax	19.4 a	18.7 ab	23.0 a	19.7 ab	16.2 abcd
Magnum	19.0 a	19.1 ab	20 abc	19.3 ab	17.7 a
Bangor	17.8 a	20.0 a	19.2 abcd	19.4 ab	14.8 abdce
Troya	17.5 a	19.1 ab	18.6 abcd	17.8 bc	14.6 cde
Kyros	17.4 ab	17.6 ab	19.7 abcd	18.2 bc	14.2 cde
Feldherr	15.2 bc	16.2 ab	16.0 bcd	14.9 cde	13.5 de
Brigadier	14.0 c	16.9 ab	13.5 d	12.7 e	13.0 e
Blaze	-	16.2 ab	14.3cd	14.1 de	-
Lifta	-	-	21.8 ab	16.8 bcd	-
Suga	-	-	21.6 ab	21.9 a	17.0 abc
Energaci	-	-	21.5 ab	19.7 ab	14.6 bcde
Rivage	-	-	15.9 bcd	14.8 cde	-
Splendide	-	-	15.0 cd	16.7 bcd	17.3 ab
Mean	17.19	17.98	18.45	17.22	15.27
LSD (0.05)	2.31	3.25	6.22	3.53	2.97

had been completed. At all sites it was determined by digging remaining parts of plants, and assessing visually, that there was not enough material left for any cultivar to warrant detailed measurement.

Data analysis

Data were analysed with GenStat 16.1. Seven cultivars were in each of the four sites, and allowed for a multi-site analysis with four replicates (Table 1). The other six cultivars were sown at two or three sites, so a one way ANOVA was employed to evaluate differences in the variables between all cultivars at a specific site. When analysis showed a significant difference, treatment differences were determined by using the least significant difference (LSD) at the 5% probability level.

Results

There were differences between cultivars for yield (Table 1), field emergence (Table 2), DM% of the bulb (Table 2), and percentage of the bulb out of the ground (Table 2).

Table 2 Dry matter percentage, percentage out of ground, and relative field emergence for a range of fodder beet cultivars.

Cultivar	DM% of Bulb	% Out of Ground	Relative Field Emergence
Cultivars in all 4 sites			
Enermax	19.7	44	101
Magnum	20.2	44	100
Bangor	17.5	46	103
Troya	17.5	44	101
Kyros	17.5	46	98
Feldherr	15.4	46	102
Brigadier	13.6	50	85
LSD (0.05)	1.1	2.5	11.9
Cultivars in North Otago, South Otago and Southland			
Suga	22.6	32	111
Energaci	19.0	41	106
Splendide	16.5	41	91
LSD (0.05)	1.8	3.4	n.s.
Cultivars in 2 sites			
Lifta	17.3	44	99
Rivage	17.1	43	96
Blaze	16.8	43	94
Mean	17.75	43.4	100
LSD (0.05)	n.s.	n.s.	n.s.

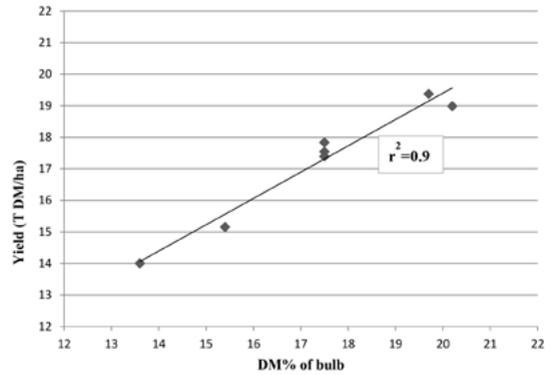


Figure 1 Relationship between DM% of bulb and yield of seven fodder beet cultivars in four trials.

‘Bangor’, ‘Feldherr’, ‘Enermax’, ‘Troya’, ‘Magnum’, and ‘Kyros’ had a higher rate of field emergence than ‘Brigadier’. Relative field emergence (mean of all cultivars = 100) ranged from 85 to 111 (Table 2). The mean relative field emergence of mono-germ cultivars was 100, and that of the only multi-germ cultivar (‘Brigadier’) was 85. The overall mean field emergence rate for mono-germ cultivars was 79 for every 100 seeds planted.

The cultivars ‘Enermax’, ‘Magnum’, ‘Bangor’, ‘Troya’ and ‘Kyros’ were more productive than ‘Brigadier’, which was similar to ‘Feldherr’ when analysed across all four sites. Within trial sites, mean yield of cultivars differed by up to 9.54 t DM/ha.

The DM% of fodder beet bulbs ranged from 13.6 to 20.2% (Table 2). There was a strong correlation ($R^2=0.9$) between the DM% of the bulb and yield of the cultivars in all four sites (Figure 1).

Table 3 Summary of seed type and intended use of fodder beet cultivars tested.

Cultivar	Mono or multi-germ	Intended use	
		Grazing	Lifting
Bangor	Mono	✓	✓
Troya	Mono	✓	✓
Enermax	Mono		✓
Magnum	Mono		✓
Energaci	Mono		✓
Feldherr	Mono	✓	
Kyros	Mono	✓	✓
Splendide	Mono		✓
Suga	Mono		✓
Lifta	Mono	✓	✓
Blaze	Mono	✓	✓
Brigadier	Multi	✓	
Rivage	Mono	✓	✓

Rust or powdery mildew were found at all sites. There were differences in tolerance between cultivars within sites (Table 4), but no overall differences across all sites. Bulb disease was not detected at any site.

The mean percentage of total crop yield across all sites was 85.8% bulb and 14.2% leaf.

Discussion

The difference in yield between cultivars makes it possible for farmers to gain significant increases in yield depending on their choice of cultivar. Yield of a cultivar is the main determinant of its profitability, as there was no evidence of differences in feed quality.

Table 4 Tolerance of fodder beet cultivars to leaf disease (9=no disease, 1=severe damage).

Cultivar	South Otago	Canterbury	Southland	North Otago	Mean
Bangor	6.8	8.8	9.0	7.5	8.0
Troya	7.8	7.8	8.5	7.5	7.9
Enermax	6.5	7.8	9.0	7.8	7.8
Magnum	7.8	7.3	8.0	8.0	7.8
Energaci	6.5	-	9.0	7.0	7.5
Feldherr	6.0	8.3	8.0	7.5	7.4
Kyros	5.8	8.8	8.3	7.0	7.4
Splendide	5.5	-	8.0	7.8	7.1
Suga	5.8	-	8.0	7.0	6.9
Lifta	5.3	-	-	7.8	6.5
Blaze	5.5	6.8	-	6.5	6.3
Brigadier	3.8	6.8	7.0	6.5	6.0
Rivage	5.0	-	-	7.0	6.0
Mean	6.0	7.8	8.3	7.3	
LSD (0.05)	2.1	1.2	1.1	0.8	n.s.

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