THE COMPOSITION AND PRODUCTIVE FEATURES OF SOME FORAGE CROPS FOR SHEEP

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ABSTRACT

Results are reported of an experiment in which swedes, turnips, medium-stemmed kale (chou moellier) and mangels were grown to measure yield of utilizable dry matter (D.M.) crop digestibility and hogget weight gain. Total nitrogen (N) and true protein nitrogen (TPN) were also measured in leaves, bulbs and stems.

Kale yielded 8830 kg of utilisable digestible D.M./ha which was about 75% more than any of the other crops. D.M. digestibility of the root crops ranged from 90.1% to 91.6%, while kale, when fed as a whole crop, gave a value of 80.0%.

Hogget gains over 6 weeks were 101-132 g/day on swedes, turnips and kale and were not significantly different. Growth on mangels at 39 g/day was lower than on the other three crops.

The leaf fraction from all crops contained 2.6 - 3.3% N and about 80% of this was TPN. Swede and turnip bulbs contained 2.9% N, mangel bulbs 1.7% N and the stem of kale 1.1 - 2.0% N. In the bulb and stem fractions 40% of the nitrogen was non-protein N.

The conclusion was reached that for both plant yield and to meet sheep winter feed requirements the kale crop sown in 15 cm rows was much superior to the three root crops.

INTRODUCTION

Although 250,000 ha of forage crops (swedes, turnips, mangels, fodder beet and kale) are grown in N.Z. each year, surprisingly little is known about the yield, feeding value and the proportion of these crops wasted by grazing animals. Scott (1971) reported experiments in which kale yielded higher levels of DM/ha than swedes, turnips, mangels or fodder beet. In one experiment hogget growth rates of 156 and 128 g/head/day on swedes and turnips respectively, were greatly superior in this work to those recorded on kale, mangels and fodder beet when the animals did not fully consume any of the crops. Small gains of 15 g/head/day were measured on kale and swedes in another experiment when hoggets were forced to harvest the entire crop.

Winter growth rates in hoggets on swedes and turnips can be as high as 150 g/day and this has been shown to be due to the high digestibility and high grazing intake (Barry **et al.** 1971).

Very little information is available on the chemical composition of forage crops in New Zealand and this is almost entirely confined to swedes and kale (Lancaster 1943). It was the intention of the present experiment to compare the chemical composition, dry matter (D.M.) yield and animal performance from turnips, swedes, kale, mangels and fodder beet. The latter crop, under the unusually dry summer conditions did not grow and will not be mentioned further in this paper.

EXPERIMENTAL

The crops were sown on 14 November 1972 and compared in a four-replicate randomised block design with 2 replicates (each of 0.053 ha) on each of two sites (called A and B) within a Wingatui silt loam. Two sites were needed in order to obtain sufficient area for the trial. A buffer zone of 1.8m between plots eliminated 'cross eating' when grazing the crops. Table 1 shows the crop production methods. Standard farm fertilizer rates were applied.

TABLE 1: Forage crop production methods

Crop	Variety sown	Sowing rate (kg/ha)	Reverted Super applied at sowing (kg/ha)	Sampling area (m^2)
Turnips	Green Globe	0.76	370*	3.66
Swedes	Calder	0.76	370*	3.66
Kale	Medium-Stem	3.00	420	1.83
Mangels	Yellow Globe	2.80	350	3.66

* 185 kg/ha was Borated Super

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The root crops were sown by a four row ridger, 61 cm between rows while the medium-stemmed kale (chou moellier) was sown through a 16 coulter combine drill with 15 cm between rows.

Sampling method for yield determination

Each replicate was sampled on 18.6.73 (216 days after sowing) just before sheep feeding commenced. Three metres of 2 rows of root crops and 4 rows of kale gave the sample areas shown in table 1. The bulbs were cleaned and separated from the leaf before weighing and sampling for drying at 80 deg. C for 16 hours. After animal feeding, the crop residues were weighed and subsampled for D.M. determination. This measurement was necessary for calculation of the proportion of the crop eaten by the sheep (utilised D.M.).

Chemical methods

All replicates were sampled for laboratory tests. The root crops were divided into leaf and bulb while kale was divided into leaf, soft and hard stem.

Bulb samples from the three root crops were cored, sliced and analysed for water, total nitrogen (N) and true protein nitrogen (TPN) according to the methods of Barry and Fennessy (1972). These procedures, which use fresh material with D.M. content determined by toluene distillation, were used in order to overcome N measurement difficulties previously encountered with root crops and thought to be associated with heat drying even at temperatures as low as 60 deg. C

The root crop leaf and all kale samples were frozen with liquid nitrogen and minced. Representative sub-samples were either freeze dried for D.M. estimation, or analysed undried for N and TPN.

Animal management

Each replicate was stocked by random allocation on 22.6.73 with 8 wether hoggets. The groups were break fed an area calculated as sufficient to give good crop utilisation during 21 days of feeding. After this first feeding period, the sheep were fasted for 24 hours, weighed and the 8 animals on each plot were randomly divided into two groups of 4 where one group remained on the site while the other 4 crossed over onto the same crop but at the other site. Feeding lasted for a second 21 day period. All sheep weights at 21 day intervals were taken after a 24 hour fast in order to minimise "gut-fill" effects.

In addition to the grazing groups 3 sheep per crop were fed unrestricted amounts in metabolism crates to measure digestibility. Cleaned and chipped bulbs from turnips, swedes and mangels were fed while the kale was cut to 6" above ground level and the entire crop chopped with a green feed cutter. All crops were fed **ad libitum.**

Statistical procedures

Analysis of variance procedures were used to examine possible site effects and Duncan's test used to compare mean crop yields and utilisation, hogget growth and some aspects of crop chemical composition.

RESULTS

Crop yield and utilisation

The total available and utilisable D.M. from each crop is shown in Table 2. Crop yields were significantly lower at site A than site B but there was no significant interaction between crop and site. There was a greater yield of total and utilisable D.M. from kale compared with the other three crops between which there were no differences. Percentage D.M. utilised by sheep was high and there were no differences between crops.

Animal performance

There were no differences in hogget rate of growth between sites and so the data for sites were pooled. Table 3 summarises the weight changes and digestibilities of the crops. Growth rates on turnips, swedes and kale were in excess of 100 g/day and were not significantly different, while growth on mangels at 39 g/day was lower than on the other three crops. Digestibility of the D.M. in kale was much lower than the other crops.

TABLE 2: The mean yield and utilisation of four forage crops at two sites.

Main effects				
Crops	Total available D.M. (kg/ha)	Total utilisable D.M. (kg/ha)	(% available DM)	Total utilisable digestible D.M. (kg/ha)
Turnips	5229 bB	4918 bB	94 a	4431 bA
Swedes	6609 bB	5930 bB	90 a	5426 bA
Kale	12 034 aA	11 038 aA	92 a	8830 aA
Mangels	6385 bB	5947 bB	93 a	5448 bA
Site effects				
Site A	6641 bA	6016 bA	91 a	5232 bA
Site B	8488 aA	7900 aA	93 a	6835 aA
C.V. %	21.1	24.0	3.9	24.1

Interactions — non significant

TABLE 3: Crop digestibility and hogget growth

Crop	Digestibility of D.M. (%)	Weight gain (g/day)
Turnips	90.1 aA	111 aA
Swedes	91.5 aA	101 aA
Kale	80.0 bB	132 aA
Mangels	91.6 aA	39 bB
C.V. %	0.92	33.1

Dry matter and nitrogen composition

The leaf fraction from each crop was analysed for D.M.% and nitrogen (Table 4). There were few differences between crops with N and about 3% of D.M. and approximately 80% of this was in the form of protein.

TABLE 4: The leaf D.M. and nitrogen composition of four forage crops

Crop	Dry matter (%)	Total nitrogen (N) (% D.M.)	True protein nitrogen (TPN) (% D.M.)	(% N)
Turnips	19.6 a	3.31 a	2.59 a	78.5 a
Swedes	17.1 a	2.59 a	2.02 a	78.3 a
Kale	15.7 a	3.03 a	2.26 a	74.3 a
Mangels	13.9 a	2.99 a	2.47 a	83.2 a
C.V. %	13.9	11.8	10.5	7.2

Table 5 shows the same measurements for the bulbs and stems.

Turnips and swede bulbs were much higher in total N and TPN content than the other crops. TPN as a percentage of N was not significantly affected by type of crop and the mean value was 58.1%. The only significant effect of site on crop chemistry occurs in this table where there were differences in N attributable to crop location. Site B in the very dry summer conditions grew more D.M./ha with all crops than Site A and the poorer crops has a higher N content than the well grown ones. Site A bulb and stem fractions had 14%, 11%, 4%, 42% and 22% higher N value than Site B for turnips, swedes, soft stem kale, hard stem kale and mangels respectively.

TABLE 5: The bulb and stem D.M. and nitrogen composition of four forage crops

Crop	Dry matter (%)	Total nitrogen (N)* (% D.M.)	True protein nitrogen (TPN) (% D.M.)	(% N)
Turnips	7.28 dD	2.87 aA	1.80 aA	62.6 a
Swedes	10.0 cC	2.87 aA	1.74 aA	60.0 a
Kale-soft stem	14.4 bB	1.96 bB	1.06 bB	54.0 a
Kale-hard stem	17.7 aA	1.10 cC	0.72 cB	66.5 a
Mangels	13.8 bB	1.68 bB	0.81 bcB	48.9 a
C.V.%	3.3	10.2	14.1	13.2

* Significant interaction between crops and sites

The necessity for supplementary winter feed for animals in the south part of N.Z. can best be demonstrated by comparing the amounts of pasture growth produced during June, July and August at Ruakura and Winton (Southland) Pasture records show that 1060 kg D.M./ha is grown during the winter months at Ruakura but only 224 kg D.M./ha at Winton (Drew unpublished).

The major requirements for feeding sheep in winter is maintenance of the breeding flock. The high yields of digestable D.M. (D.D.M.) in the present experiment clearly shows the superiority of the medium-stemmed kale (chou moellier) crop over root crops for this purpose. Kale produced about 62% more utilisable digestible D.M. (DDM)/ha than swedes and mangels and 100% more than turnips. These figures closely support the conclusions of Scott (1971) who found that kale outyielded root crops in DDM/ha by more than 100%. Site B in the present experiment was less affected by lack of rainfall than site A and crop yield differences between sites were about 25%, although there were no significant interactions between crop and site. A kale crop when compared with other forage crops appears to be clearly superior for animal maintenance both in favourable and in less favourable environments.

In addition to ewe maintenance feeding, forage crops are frequently fed to hoggets during the winter. Growth in hoggets fed on mangels was greatly inferior to all other crops and this is in line with the data from Scott (1971). Performance on kale in the latter's experiment was inferior to that on swedes and turnips, a result in contrast with the present experiment. Scott sowed his kale at 36 cm inter-row spacings compared with 15 cm in this work, with the result that his crop probably had a greater proportion of hard stem, and consequently a lower D.M. intake by the sheep. The fact that it is possible to suppress growth rates on swedes and kale to 15 g/head/day by heavy stocking pressure (Scott 1971) emphasises the need for skilled management with these crops to achieve the highest rate of growth.

Drew **et al.** (1973) have shown that there is little disadvantage to hoggets wintered at a modest level of nutrition because they compensate for this penalty by growing faster during the subsequent spring-summer on pasture. It is, therefore, more important to achieve high yields of D.M. from winter crops than it is to achieve high digestibility providing the rations will support some growth. Kale would be recommended as the best all purpose winter crop for sheep feeding. In spite of this, the area sown in swedes and turnips each year in N.Z. is more than three times that sown in kale (N.Z. Official Year Book, 1973).

The digestibility of root crops at about 90% (D.M.) has repeatedly been shown to be as high as any feeds (Drew, 1967 and 1968, Barry **et al.** 1971) and much higher than spring grass which usually has a D.M. digestibility in the range of 80-84% (Hutton, 1962). The present experiment shows that not only is the leaf fraction of these crops high in nitrogen (about 3%) but the bulb fraction of swedes and turnips at 2.9% N is almost as high as the leaf. Crude protein values in feeding tables are usually computed by multiplying N x 6.25 because protein is 16% N. While the crude protein content of mangels in the present work is very similar to that recorded in some feeding value tables (Morrison, 1959, A.R.C. 1965), swedes and turnips are about 40% higher than Table values. Since most of the N in forage crop leaf is "true protein" it is reasonable to compute crude protein values by multiplying the N content by 6.25. The computing of bulb and stem crude protein in a similar manner does not seem reasonable when this experiment shows that 40% of the nitrogen is not in the form of protein. Ruminant animals will, however, probably utilise this NPN form of nitrogen quite efficiently by microbial protein synthesis aided by the high content of readily digested carbohydrate. The high bulb N contents in swedes and turnips in the South part of the South Island may be a function of the favourable growth environment in that part of the country.

The soft stem fraction of kale, although lower in N than swede and turnip bulbs has an adequate supply for animal growth. The hard stem fraction would be classified as protein deficient and cultural practices such as increasing the plant density by closer spacings and rows should be encouraged to minimise the proportion of this component in kale.

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