SWEET SORGHUM AND BEET CROPS FOR ENERGY IN NORTHERN NORTH ISLAND

G.J. Piggot and C.A. Farrell
Agricultural Research Division
Ministry of Agriculture and Fisheries
Whangarei and Auckland

ABSTRACT

As a preliminary stage in an energy farming research programme, fodder and sugar beets were grown at Pukekohe, and sweet sorghum at Pukekohe and 4 sites north of Auckland during the summer of 1979-80. Fodder and sugar beets yielded similar bulb dry matter (17.4 and 17.8 t/ha respectively) and sugar (13.9 and 14.6 t/ha respectively). Sweet sorghum cv. Sugar Drip yielded from 16 to 26 t DM/ha by the soft dough stage with 16 to 19% sugar content in stem juice; this was calculated to provide from 3 to 5 t/ha of mill-extractable sugar.

INTRODUCTION

Energy farming for ethanol has recently generated considerable national interest (N.Z.E.R.D.C., 1979) but information regarding the potential of 'energy crops' is sparse. Ethanol, produced by yeast fermentation of sugar in energy crops, could provide competitively priced motor spirit for rural transport and farm machinery. Ethanol is produced most economically when the feedstock is high in fermentable sugars. Sugar or fodder beets appear to be promising energy crops as yields of sugar can be high. Sweet sorghum, while having lower sugar yields, is possibly better adapted to northern regions in New Zealand than beets. To provide information on plant development and yield of sugar/fodder beets and sweet sorghum in northern New Zealand, preliminary trials were conducted over the 1979-80 season.

MATERIALS AND METHODS

Beets

One trial comparing 2 sugar beet cultivars (Monoire and Vytomo) and 2 fodder beet cultivars (Peramono and Solanka) was conducted on Patumahoe clay loam at the DSIR Research Station, Pukekohe. Kale cv. Kestrel was sown as a control. The site was cultivated and the trial laid out in a randomised block design with 5 replicates of 1.5 m x 10 m plots. Plots were sown at 5 kg/ha in 30 cm rows by a Stanhay drill on 18 October, 1979. Fertiliser applied was 660 kg 30% potassic superphosphate/ha prior to sowing plus 120 kg/ha of starter NPK (12:10:10) at sowing. Nitrogen, 300 kg/ha as urea, was broadcast on 3 December. Lenacil (2.4 kg a.i./ha) was incorporated immediately prior to sowing and ethofumesate (1 kg a.i./ha) was applied on 9 November. Two hand weedings were conducted (26 November and 10 January). Yield was assessed after 6 months (23 April) by quadrat sampling (2 x $0.6m^2$ per plot).

Sweet Sorghum

Sweet sorghum cv. Sugar Drip or Saccaline was sown at 5 sites located at Pukekohe, Otakanini (Parakai), Ruatangata, Dargaville, and Kaikohe. With the exception of the Otakanini site, the sweet sorghum was compared with sudax (sorghum/sudan grass hybrid) in a randomised block design in 4 replicates on 2 m x 5 m plots. All trials were sown during the last fortnight of November, 1979. Seed was drilled at 20 kg/ha in 15 cm or 30 cm rows. Phosphate and potassic fertiliser was applied according to soil test; 50 kg N/ha as urea, and atrazine was applied at sowing. Yield assessment was by hand harvested quadrat sampling at the late-milky or soft dough stage (late April).

Sugar yield was estimated by expressing juice from the bulb of beets and from the stem of sweet sorghum. The juice was tested by refractometer, the result being assumed to indicate the percentage of sugar in the green material. Mill-extractable sugar yields for sweet sorghum were calculated using the following assumptions:-
(i) stems being 60% of green yield (measured at each site);
(ii) 50 kg of juice being extracted per 100 kg of green sweet sorghum stems (Dogget, 1970). No similar extraction % is available for sudax.

RESULTS

Beets

Yield data are given in Table 1 for fodder beet, sugar beet, and kale. There were no significant differences between cultivars of fodder or sugar beet. Fodder beet produced more root yield than sugar beet but its dry matter and sugar yields were not significantly different from sugar beet.

TABLE 1: Crop green material, dry matter and sugar yields (t/ha) of fodder beet, sugar beet and kale (roots for beets, herbage for kale).

	Green Yield	Dry Matter Yield	Sugar Yield
Fodder beet	124	17.5	13.9
Sugar beet	76	17.8	14.6
L.S.D. 5%	23	3.7	0.8
Kale	110	13.3	—

Sweet Sorghum

Plant development was similar at each site — boot stage, late February; milky, mid-April; hard dough, early May. Sudax at any date was more advanced in plant development. Yield data from three sites are given in Table 2. Dargaville and Kaikohe crops were sown with cv. Saccaline, the seed of which had low germination, and stands were sparse. Therefore crop yields were not included in Table 2 although the plants grown at these sites had similar sugar % in stem juice to those at the other sites for each stage of development.

TABLE 2: Yield of dry matter (t/ha), stem juice sugar % of sudax and sweet sorghum cv. Sugar Drip, and estimated mill-extractable sugar yields (t/ha) of sweet sorghum.

Site	Crop	Crop DM	Sugar % in stem juice	Estimated mill-extractable sugar
Otakanini	Sweet sorghum	26	17	4.7
Pukekohe	Sweet sorghum	15	16	2.6
	Sudax	14	16	—
Ruatangata	Sweet sorghum	20	19	3.4
	Sudax	16	18	—
	L.S.D. 5%	5	2	—

Sudax yielded similar DM/ha to sweet sorghum at Pukekohe and Ruatangata and stem juice sugar % did not differ between crops.

DISCUSSION

Sugar yields of beets, at approximately 14 t/ha, were high at Pukekohe when compared with other New Zealand data (T.P. Palmer — submission to N.Z.E.R.D.C., 1979). These yields might be improved upon, for two reasons. First, the moderate performance of the control species, kale, suggests that features of the site limited its yield and, by implication, the yield of the beets. Kale was chosen for comparison because its growth pattern was similar to the beets and more is known about its dry matter yield; for example the yield of good kale crops in Northland can exceed 20 t DM/ha over this period (Piggot *et al.,* 1980) compared with 13 t DM/ha in this trial. Secondly, this trial was not necessarily conducted under optimum management. Decisions relating to choice of site, cultivars, sowing date, fertiliser, seeding rate, plant spacing, weed control methods, and harvest date were made arbitrarily. Research on these topics is needed, weed control being the prime problem.

Sweet sorghum and sudax dry matter yields from these trials compared favourably with yield data presented by Gerlach and Cottier (1974) for this and other regions in New Zealand. Yields were similar to those recorded in the trials of Taylor *et al.* (1974) conducted in Northland, although stem sugar contents were not as high. Different methods of sugar measurement may account for this difference, although the abnormally low temperatures in March allied with low sunshine hours over the entire 1979-80 summer may have influenced sugar production in these trials. Harvest date may also have been too early for maximising sugar yield (Dogget, 1970).

Sudax had similar dry matter yield and stem juice sugar % to sweet sorghum. The similar sugar levels in stems from a range of sorghums was also noted by Taylor *et al.* (1974). However, in our trials, the sweet sorghum produced fewer and larger stems/ha than sudax so that sweet sorghum yielded more juice/stem. This character is important if roller milling is used to extract sugar but may not be so if the whole stem is processed, i.e. if the stem is chopped and the stem fragments are fermented or subjected to sugar extraction. The processing technology for sweet sorghum suited to New Zealand conditions is presently unclear.

Sweet sorghum sugar yields were low when compared with the beets but this may not determine their relative roles as energy crops. Sorghum does not require the same careful site selection or the intensive or costly management which beet culture demands. Sorghum also has a shorter growing season allowing a complementary winter-spring crop to be grown. If the sorghum juice is extracted in the field the residue could be ensiled for animal feeding. Field juice extraction would simplify sugar processing and ethanol production could be decentralised with a possible cost saving. Some agronomic aspects of sorghum culture need elucidation however, in particular cultivar/hybrid differences, plant populations, sowing dates, nitrogen requirements and harvest timing.

ACKNOWLEDGEMENTS

We thank E.N. Honore, H.M. Morgan and G.L. Stebleton for assistance with trial management, M.P. Upsdell for statistical analyses, and the owners of the sites for their interest and co-operation.

REFERENCES

Dogget, H. 1970. "Sorghum", Longmans, Green & Co. Ltd., London.

Gerlach, J.C., Cottier, K. 1974. The use of sorghums as forage crops. *Proceedings Agronomy Society of N.Z. 4:* 83-85.

N.Z.E.R.D.C., 1979. The potential of energy farming for transport fuels in New Zealand. Report No. 46, N.Z. Energy Research and Development Committee, University of Auckland.

Piggot, G.J., Farrell, C.A., Stebleton, G.L., Shannon, P.W. 1980. Summer brassica forages in Northland. *Proceedings Agronomy Society of N.Z. 10:* 39-42.

Taylor, A.O., Rowley, J.A., Esson, M.J., Eastin, J.D., Wallace, R. 1974. Sorghums for conserved feed in Northland. *Proceedings Agronomy Society of N.Z. 4:* 74-78.