°BRIX AND DRY MATTER CONTENT AS INDICES OF UREA REQUIREMENTS IN DIETS BASED ON SUGAR CANE

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°Brix and dry matter were determined in samples of chopped whole sugar cane used for feeding cattle in the experimental cattle unit of CIEG from February 1975 to November 1976. In general, °Brix rose to values over 19 during the period March to August/September and then dropped sharply to levels of about 11 in October and 9.5 in November, and started to rise again in December. Values for dry matter showed similar tendencies with figures of 27% in March rising to 31% in June. The lowest mean value of 15.4% was observed in November. Rainfall was concentrated in the months of August/September and October. The most intensive dry period occurred in April, May and June when there was almost no rainfall. There was a very close relationship between dry matter content (Y%) and !Brix of the juice ($Y = 5.19 + 1.12$; $r^2 = .93$). In addition, there was a significant relationship between !Brix in the juice (Y) and monthly rainfall (X = mm) in the previous month ($Y = 17.5 + 0.15X$; $r^2 = 40$) and between dry matter content (Y%) and rainfall (X = mm) rainfall in the previous month ($Y = 27.0 + 0.02X$; $r^2 = .39$) . There was no relationship p between !Brix in the juice and rainfall in the same month ($r^2 = .13$), nor between °Brix and rainfall 2 months before ($r^2 = .27$). A theoretical calculation of total sugar percent of the dry matter was carried out using the following formula - sugars in dry matter = 100°Brix (100-DM)/(100 °Brix) DM. It was then assumed that for every 100 g of fermentable carbohydrate, the rumen could produce 3 g nitrogen in the form of microorganisms. This would require 6 g of urea per 100 g fermentable carbobydrate or 60 g urea per kg of fermentable carbohydrate. Consequently the urea requirement per kilo gram of fresh cane could be derived from = 0.6 °Brix (100 - DM)/(100 - Brix). On substituting the function for dry matter according to the formula mentioned (to predict dry matter from °Brix) the urea requirement (g/kg fresh cane) could be expressed as 0.6 Brix (94.81 - 1.12°Brix)/ (100 - °Brix).

Key words: sugar cane, seasonal, composition, cattle urea

The importance of maintaining an adequate nitrogen - energy relation ship in ruminal fermentation is universally accepted, especially when a high proportion of the dietary nitrogen is NPN (McMeniman et al 1976)

Alvarez and Preston (1976) demonstrated the importance of urea in rations based on sugar cane, and concluded that the optimum level was 10 g urea/kg fresh cane. However, the composition of sugar cane varies according to the vagaries of the environment principally nitrogen and rainfall. Age is another important factor which affects sugar concentration (Anon 1974; Banda et al 1976). Given the variability in these factors, it is difficult often to maintain an adequate nitrogen energy relationship.

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The purpose of this paper is to clarify of the effects of some environmental factors on sugar cane and to present a possible method of determining NPN requirement for any given sample of sugar cane, in order to maintain a stable nitrogen: energy relationship.

Materials and Methods

During 1975 and 1976 determinations were made daily of dry matter (48 hr at 70°) and °Brix (by hand refractometer on juice) of the sugar cane (the entire plant including stalk and top) fed to the experimental animals in the centre. Rainfall was also recorded.

Results

Monthly mean values for °Brix, dry matter and rainfall from February 1975 to November 1976 are in table 1. Rainfall is shown in figure 1 and the °Brix of the juice in figure 2.

The results of regression analyses between the variables are given in table 2.

It is apparent that there is a close relationship between dry matter and °Brix. Brix and dry matter are also so predicted better by rainfall in the previous month than by rainfall in the same month. The regression between °Brix and rainfall two months previously was also calculated, but the predictive power of this equation was low (r2= .27).

Table 1 :
Mean monthly values (X - SEx) values for rainfall, Brix and day matter in whole sugar cane

	Month	°Brix	DM (%)	Rainfall (mm)	Month	°Brix	DM (%)	Rainfall (mm)
1975	F	18.27-.25	28.4±1.31	21.7	F	14.94±.31	24.06±.20	27.6
	M	19.35-.42	27.7±.74	62	M	19.36±.34	27.56±.77	6.2
	A	20.31-.49	28.5±.83	2.7	A	21.5±.23	29.7±.92	1.6
	M	21.57-.40	28.3±.42	3.8	M	20.81±.66	28.34±.81	189.9
	J	19.8+.49	26.76±1.73	1.4	J	11.38±.47	20.71±.54	108.1
	J	18.24-.50	31.19±1.26	11.8	J	10.44±.22	20.0±.43	99.6
	A	18.2-.33	30.14±1.0	87.2	A	12.03±.16	22.85±.37	62.5
	S	17.55-.43	27.5±.42	269.1	S	12.5±.24	24.35±.77	82.5
	O	10.06-.44	20.9±.3	307.8	O	14.26±.25	27.69±.28	73.6
	N	9.51-.82	15.34±.49	57.2	N	15.89±.21	29.00±.41	27.9
	D	12.36-.63	20.14±.73	21.6				
1976	J	12.51-.47	21.2±.43	56.2				

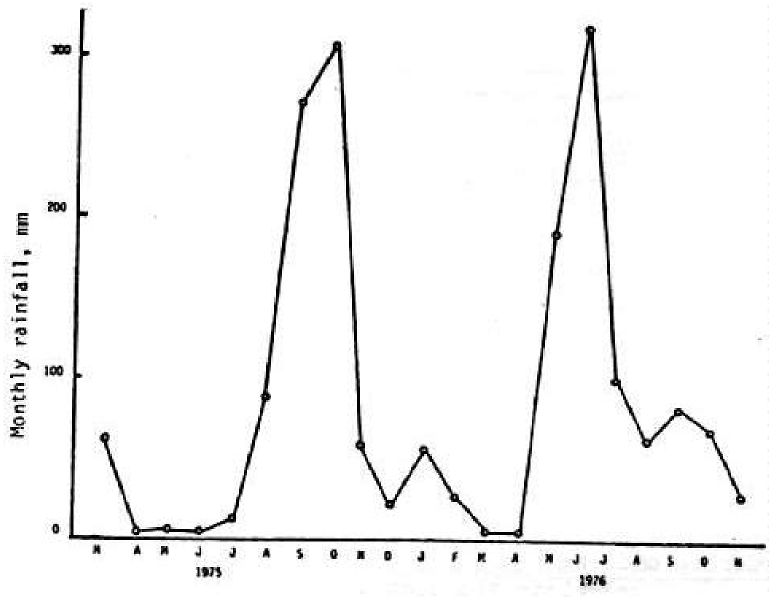

Figure 1:
Monthly rainfall during1975 and 1976

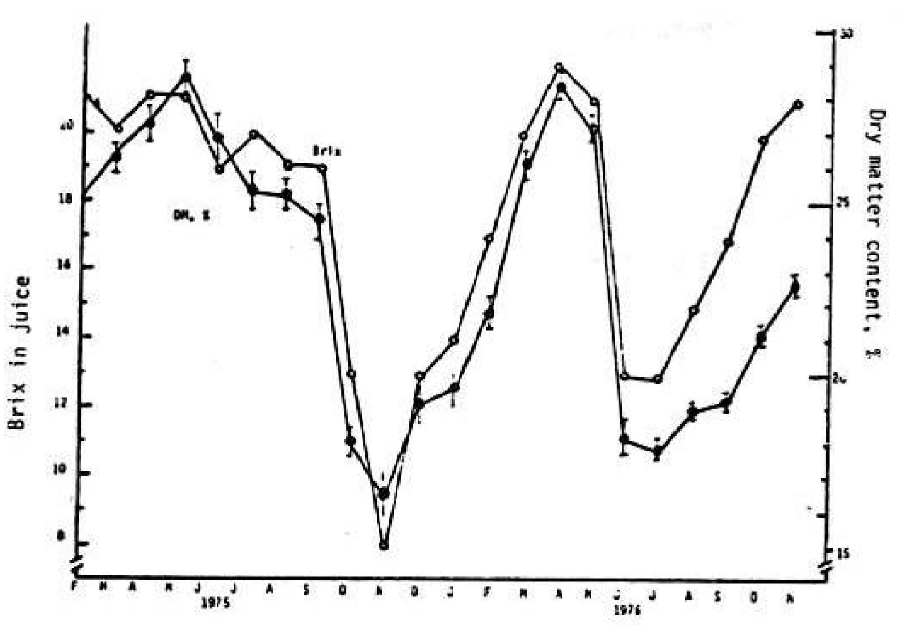

Figure 2:
Mean values for dry matter content and brix in juice of sugar cane
(stalk plus tops) during 1975 and 1976

Table 2:
Regression relationships between Brix and DM in cane and rainfall

Dependent variable Y	Independent variable X	Regression	r^2
DM	°Brix	Y = 5.91 + 1.12X	.93
°B	rainfall (mm) same month	Y = 329 - 14.4X	.13
DM	rainfall (mm) same month	Y = 406 - 12.1X	.10
°B	rainfall (mm) previous month	Y = 17.5 - 157X	.40
DM	rainfall (mm) previous month	Y = 27.0 - 0.02X	.39

These data suggest that total sugars (°Brix) are closely related to dry matter, and hence the reason for the decline in nutritive value of sugar cane during the wet season (see Lopez et al 1976) may well be due to reduction in dry matter and°Brix caused by increased rainfall.

In order to utilize this information for predicting urea requirements, we need to calulate the quantity of sugar (S=g) (easily fermentable carbohydrate) per kg of cane dry matter (DM). (DM=%). This can be derived as follows.

$$\text{°Brix in Juice (°B)} = \frac{S \times 100}{S + (100 - DM)} \text{ ....1)}$$

$$\text{Percent sugar in DM} = \frac{S}{DM} \times 100 \text{ ....2)}$$

Rearranging 1)

$$°B \times S + 100\ °B - °B \times DM = 100\ S$$
$$S\ (100 - °B) = °B\ (100 - DM)$$
$$S = \frac{°B\ (100 - DM)}{(100 - °B)}$$

Then substituting into ....2)

$$\text{Sugar in DM (\%)} = \frac{(100 - DM)\ °B \quad x100}{(100 - °B)\ DM}$$

According to literature estimates, from 1 to 4 g of nitrogen can be obtained from the bodies of microorganisms produced by the fermentation of 100 g of carbohydrate. Recent data (McMeniman et al 1976) report a mean of about 3 g nitrogen per 100 g fermentable carbohydrate. Thus we can deduce that there is a requirement for about 6 g of urea (48 % nitrogen) per 100 g of fermentable carbohydrate. Assuming that the main source of fermentable carbohydrate in cane is the solu ble sugars (Valdes & Leng 1976) then:

$$\text{g Fermentable sugar/kg fresh cane} = \frac{°B\,(100 - DM)}{DM\,(100 - °B)} \times 10 \times DM$$

Thus amount of urea required (g) per kg fresh cane=

$$\frac{6}{100} \times \frac{°B\,(100 - DM)}{DM\,(100 - °B)} \times 10 \times DM$$

Substituting the °B/DM equation (from table 2)

$$\text{Then, urea needed (g/kg fresh cane)} = \frac{0.6\ °B\,(94.81 - 1.12\ °B)}{100 - °B}$$

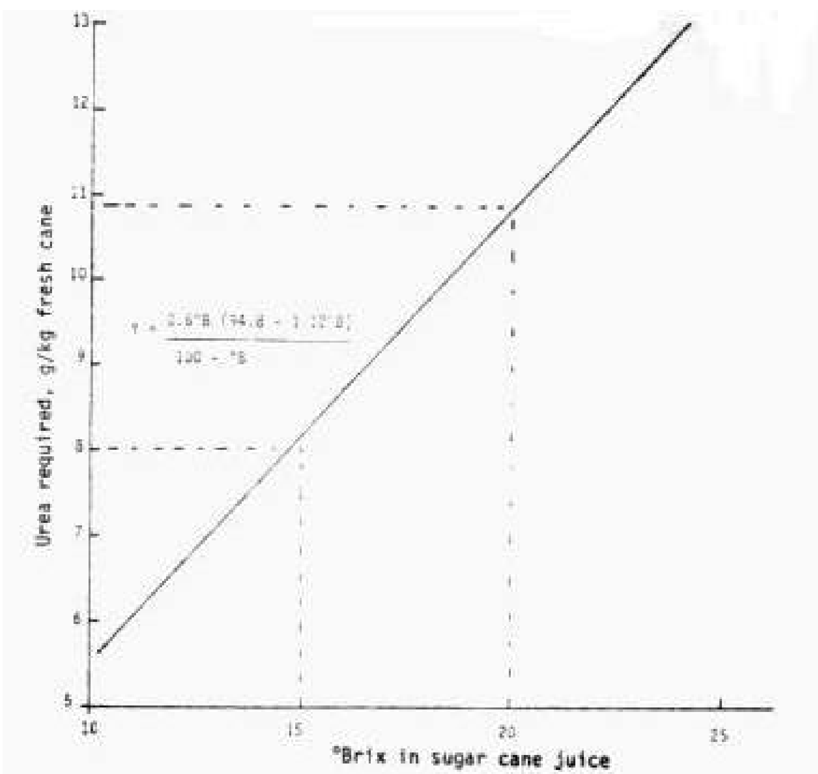

Figure 3:
Estimation of urea required to supplement fresh cane according to Brix in juice

Discussion

°Brix is actually a measurement of the percent of soluble solids in the juice. In the case of cane, it can be taken as an estimate of the concentration of sugars and due to the easy and rapid nature of its determination, and its close relationship with percent DM, is without any doubt the most adequate parameter on which to base calculation of urea requirement per unit of cane. The relationship between °Brix and urea requirements is shown in figure 3.

The estimate of 3 g of microbial nitrogen produced from the fer mentation of 100 g of carbohydrate agrees with theoretical calculations carried out by Blackburn (1975 unpublished data) and Sutherland (1976, unpublished data) based on performance trials carried out by Ferreiro and Preston (1975) and Alvarez and Preston (1976). The next and most important step is to test this method of determining urea requirements in terms of animal performance.

Conclusion

By estimating the Brix of a particular cane sample it is feasible to calculate the quantity of urea/per k of fresh cane which will maintain a nitrogen energy relationship adequate for efficient ruminal fermentation.

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