THE EFFECTS OF NITROGEN FERTILIZATION AND TIME OF CUTTING IN FIRST GROWTH IN BRACHIARIA BRIZANTHA ON YIELD, CRUDE PROTEIN CONTENT AND IN VITRO DIGESTIBILITY

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The effects on dry Datter yield, crude protein content and in vitro digestibility of four different levels of nitrogen fertilizer application on almost pure Brachiaria brizantha were studied in two consecutive years. The levels were 0, 62.5, 125.0 and 187.5 kg N/ha, applied as ammonium sulphate. The results for the two years were significantly different for all parameters. Increased dry matter yield in response to increased N level was significant by the 1st harvest - year 1, but not until the 3rd harvest - year 2. Fertilizer N was rapidly taken up by the plants giving a maximum difference of 10% at first harvest in both years. In vitro organic matter digestibility tended to increase from 1st to 3rd harvest in the first, but not the second year.

Key words: N fertilizer, Brachiaria, yield, protein content, digestibility

Under monsoonal conditions, reliable pasture production is limited to the periods of rain. In Tanzania (Morogoro region) pasture production is mainly based on natural bush savanna-grassland, and nitrogen deficiency is a typical condition. According to Madallali (1974), Brachiaria brizantha is one of the most promising species in Tanzania. At the university farm, a well maintained stand was available for research with the objectives of studying the response to nitrogen fertilization applied before the onset of the main rain, combined with cutting at advancing stages of maturity during the rainy period.

Materials and Methods

In two succeeding years (1973 and 1974) a 4 x 4 latin square plot design was laid out in an almost pure stand of a 6-7 year old plot of Brachiaria briizantha. Levels of nitrogen application were 0, 62,5, 125.0, and 187.5 kg N per ha as ammonium sulphate in one dressing before the commencement of the main rain (9th March 1973, and 6th April 1974). Other fertilizers were not applied. 10 sq metres of each plot of 200 sq metres were harvested once a week over a period of eight weeks. The crop was cut with knives almost to ground level and weighed. A sample from each plot was dried in an oven with air circulation at 90°C. The dried samples were milled through a screen of 0.8 mm and subjected to analysis for nitrogen and in vitro digestibility (Tilley and Terry 1963), using 2 x 48 hr digestion periods. Rumen fluid was obtained from a sheep fitted with a permanent rumen fistula. The donor animal was fed a good quality hay plus concentrate mixture made of maize bran and cottonseed cake.

Growth curves were established using the quadratic equation

$$y = a + b_1x + b_2x^2$$

where x is harvest number at weekly intervals. It was thought that yields and crude protein content could be described best by this function, while it was not possible to describe the development curves for digestibilities which may increase in the earlier stages of growth.

Rainfall was recorded at a meteorological station about 1 km from the experimental field as reported in Table 1.

Table 1:
Rainfall per month at the University Farm, Morogoro

	1973 (mm)	1974 (mm)
March	41	86
April	291	279
May	77	102
June - February	563	120
Total	972	587

Results

The relationships between week number (harvest rate) and yield of dry matter, organic matter, crude protein and crude protein per cent are shown in Table 2 and 3.

Apart from yield of crude protein the R^2 values indicate that most of the variation can be accounted for by the harvest date within the rain period. The analysis of variance showed significant differences (P <.01) between years for all items.

Table 2:
Quadratic equations ($y = a + a + b_1 + b_2x^2$) on week number in the experiment in 1973

N level	a	b_1	b_2	R^2	sy	Maximum	
						week	yield/pct
Yield of dry matter, tons per hectare							
0	0.51	0.532	-0.30	0.90	0.26	8	2.81
62.5	0.68	1.049	-0.051	0.96	0.35	8	5.82
125.0	0.89	1.456	-0.057	0.97	0.50	8	8.90
187.5	1.02	1.694	-0.075	0.99	0.31	8	9.79
Pct crude protein in dry ratter							
0	8.72	-1.396	0.130	0.78	0.53	1	7.4
62.5	13.27	-2.192	0.139	0.92	0.51	1	11.2
125.0	20.06	-4.070	0.278	0.94	0.61	1	16.3
187.5	22.16	-4.145	0.288	0.98	0.72	1	18.3
Yield of crude protein, kg per hectare							
0	81	0.9	1.2	0.94	8	8	164
62.5	177	35.5	-3.2	0.38	35	6	277
125.0	410	15.4	-1.3	0.10	37	6	455
187.5	493	54.0	-3.7	0.33	89	7	6.90
Yield of digestible organic ratter, tone per hectare							
0	0.37	0.170	-0.008	0.94	0.07	8	164
62.5	0.52	0.508	-0.030	0.95	0.17	8	2.68
125.0	0.45	0.894	-0.061	0.95	0.25	7	3.72
187.5	0.67	0.944	-0.066	0.94	0.27	7	4.03

Table 3:
Quadratic equations (y =a + a + b_1 + b_2x^2) on week number in the experiment in 1974

N level	a	b_1	b_2	R^2	sy	Maximum week	Maximum yield/pct
Yield of dry matter, tons per hectare							
0	0.75	0.697	-0.054	0.85	0.29	6-7	3.01
62.5	0.97	1.239	-0.068	0.99	0.23	7	6.32
125.0	-0.23	1.867	-0.111	0.91	0.80	8	7.64
187.5	-1.10	2.426	-0.158	0.99	0.31	8	8.17
Pct crude protein in dry ratter							
0	12.64	-1.761	0.108	0.90	0.781	1	11.0
62.5	15.85	-2.581	0.160	0.98	0.43	1	13.4
125.0	26.63	-5.417	0.376	0.95	1.42	1	21.6
187.5	25.79	-3.424	0.121	0.95	1.10	1	22.5
Yield of crude protein, kg per hectare							
0	137	26.5	-3.1	0.38	24	4	193
62.5	258	51.4	-5.2	0.64	25	5	390
125.0	208	161.1	-15.7	0.50	108	5	621
187.5	51	329.1	-34.4	0.86	82	5	836
Yield of digestible organic ratter, tone per hectare							
0	0.107	0.568	-0.054	0.74	0.23	5	1.60
62.5	0.174	0.995	-0.088	0.93	0.22	6	2.96
125.0	-0.466	1.344	-0.106	0.92	0.37	6	3.77
187.5	-0.907	1.611	-0.131	0.96	0.27	6	4.09

It appears that the established constants in the equations differ between the two years. Therefore, more work is needed before the equations can be recommended for prediction purpose.

Dry matter yield: A few showers occurring in March 1973 were sufficient to start the growth, resulting in a significant (P <.01) difference in dry matter production between treatments already at the first harvest date as shown in Figure 1. As shown a continued growth was observed in 1973 for all treatments throughout the 8 week period. The dry matter yields after the 8th week were 2.8, 5.8, 8.9 and 9.8 tons per hectare at 0, 62.5, 125.0 and 187.5 kg N per hectare, respectively. In 1974 the fertilizer was applied when the main rain had begun, and no significant differences occurred between treatments until the 3rd harvest. The reason was that the crop was burned almost white on the heaviest dressed plots because the fertilizer was applied on the wet crop. The yields in the heavily fertilized treatments were a little less than in 1973. Dry matter yield for the four treatments at the 8th week were 2.9, 6.2, 7.6 and 8.2 tons per hectare, respectively. There was a tendency to less dry matter at the 8th than at the 7th week at 0 and 62.5 kg nitrogen per hectare, due to senescence and maybe microbial growth. The maximum response per kg fertilizer nitrogen was in 1973: 48, 49 and 37 kg and in 1974: 53, 37, and 28 kg dry matter for the 62.5, 125.0 and 187.5 kg nitrogen per hectare, respectively.

Figure 1:
Yield of dry matter at 4 N-levels and advancing stages of maturity

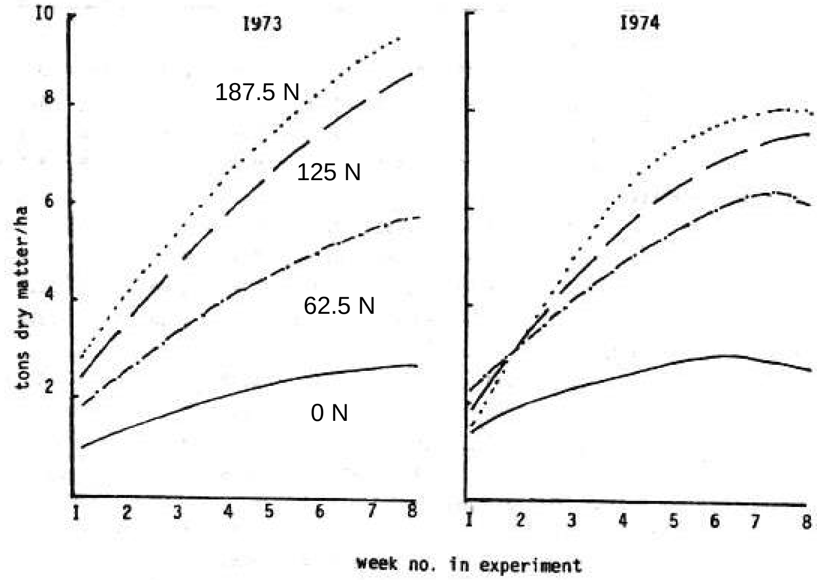
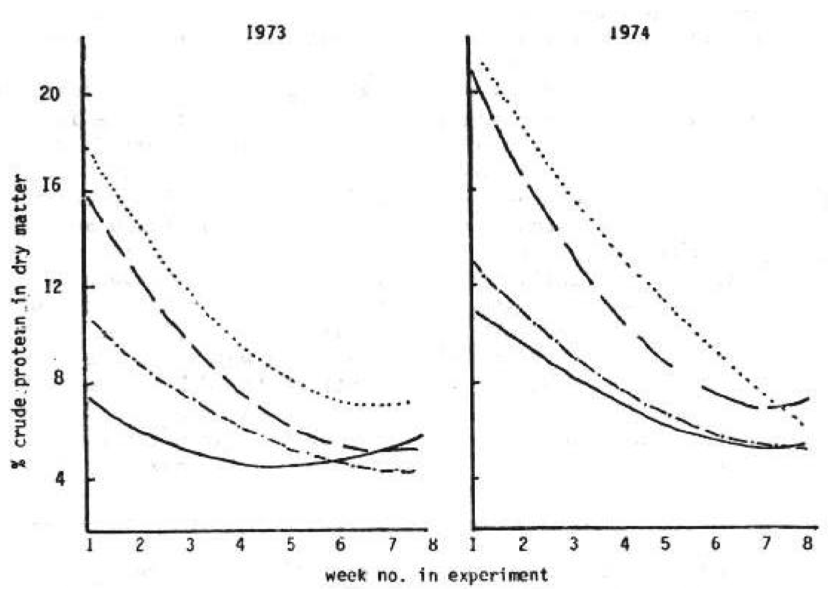


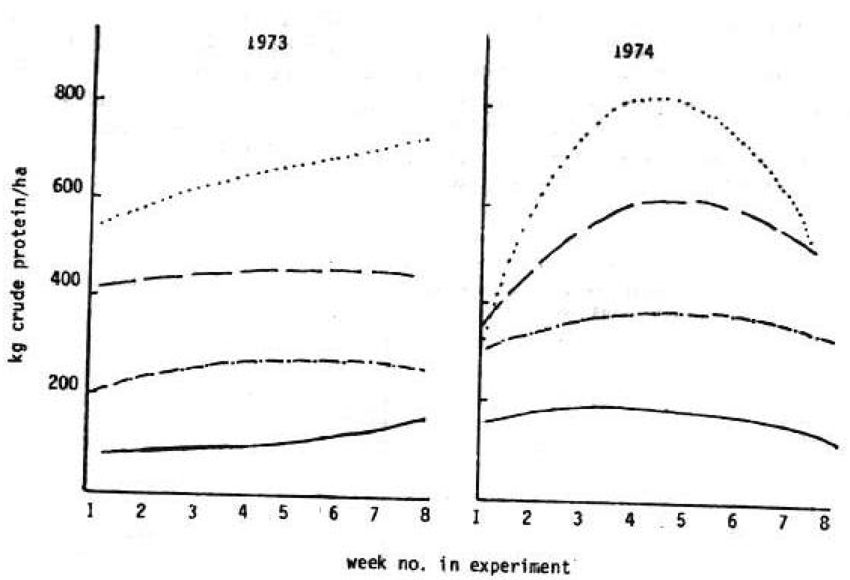
Figure 2:
% Crude protein in the dry matter at 4 levels of nitrogen fertilization and advancing stages of maturity (signature sec Fig.1)



Crude Protein Content: As shown in Figure 2, the fertilizer nitrogen was very rapidly taken up by the plants, resulting in marked differences between the content of crude protein in the four treatments. The differences between zero and the highest amount of nitrogen were for both years about 10 per cent units at the first harvest. Despite these differences there were only 2 to 3 per cent units differences between treatments at the 8th week for both years. The average figures were 5.9, 4,6, 5.4 and 7.6 in 1973 and 5,5, 5.4, 7.4 and 6.1 in 1974 for each treatment.

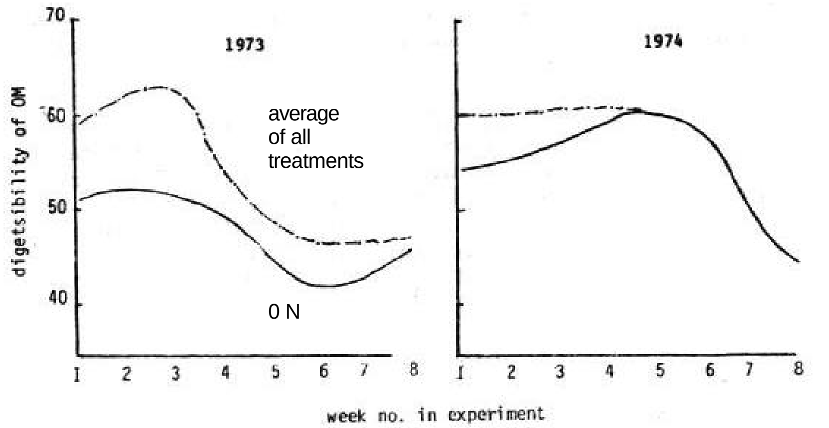
Crude Protein Yield: Figure 3 shows the yield of crude protein. In both years significant differences (P <.001) were found between the four treatments. In 1973 maximum yield was reached toward the end of the experimental period, while in 1974 maximum yield occurred around the 5th week. The decrease in yield after the 5th week may be due to a faster rate of senescence and a decomposition of leaves rather than to a growth of stemmy materials, rendering a crop poorer with regard to crude protein. Maximum recovery rates of fertilizer nitrogen were in 1973: 38, 42, and 48% and in 1974: 50, 55, and 55% at the three levels, respectively.

Figure 3:
Yield of crude protein at 4 N-levels and advancing stages of maturity
(signature see Figure 1)



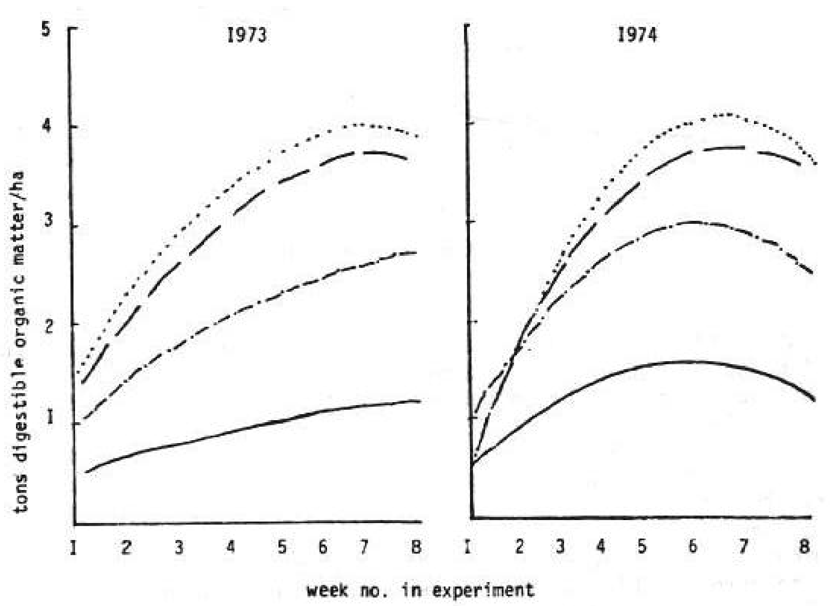
In Vitro Organic Matter Digestibility: Figure 4 shows a clear tendency to increasing digestibility from 1st to 3rd harvest date in 1973, but not 1974. Early in the growth season the values for the fertilized plots were about 60% in both years. This value was persistent up to the 5th harvest in 1974, while in 1973 a decrease in digestibility occurred already after the 3rd harvest. At the end of the growth season the average digestibility was about 45% for both years. The effect of the various nitrogen treatments appears from the following average digestibilities in 1973: 48, 54, 54 and 53 and in 1974: 55, 54, 59 and 57 for the four treatments, respectively. The only significant difference occurred in 1973 where the zero-nitrogen treatment was significantly lower (P < 0.001) than the other treatments.

Figure 4:
In vitro organic matter digestibility at 4 N-levels and advancing stages of maturity



Yield of Digestible Organic Matter: Maximum yield of digestible organic matter was obtained towards the end of the growth season in 1973, while this level was reached at the 5th or 6th harvest in 1974 (Figure 5). Significant differences were obtained for all treatments apart from the differences between 125.0 and 187.5 kg N/ha in 1974. The maximum responses to nitrogen fertilization above zero-nitrogen were 23, 20 and 15 in 1973 and 22, 17 and 13 kg digestible organic matter per kg nitrogen in 1974 for 62.5, 125.0 and 187.5 kg N/ha, respectively.

Figure 5:
Yield of digestible organic matter at 4 N-levels and advancing stages of maturity (signature see Fig.1)



(The curves are drawn free hand based on average figures on each cutting date.)

Discussion

In practice the production from most tropical grasslands is limited by water and soil nutrients, particularly nitrogen. Present evidence (Cooper 1970) suggests that for crops grown without limitations and harvested in order to obtain optimum growth rate, the biological potential yield depends on the solar light energy and temperature.. According to Trewarthe (1968) the Morogoro region has a total solar radiation to yield a sufficient input of energy for an annual production of 51 tons of dry matter per hectare equivalent to about 9 tons dry matter per hectare in the heavily fertilized plots. Such a comparison may, however, be misleading as daily growth rate declined with advancing maturity and was even negative in the mature crop at zero and the lowest nitrogen level in 1974. This indicates that alternative management techniques may affect growth rate and hence dry matter production as shown by Gartner (1966) working with Panicum maximum and Pennisetum clandestinum in Australia and Brockman (1966) working with temperate species in Britain.

The maximum response in Dry Matter yield per kg fertilizer nitrogen was declining with increasing fertiliser level while yield of crude protein and recovery rate were increasing. The figures obtained can not immediately be compared with published figures because of local conditions. However, the trends are similar to those reviewed by Cooper (1970) that moat species respond in dry matter yield almost linearly up to a certain level while crude protein yield continues to increase linearly to a far higher liver. This may be due to the fact that nitrogen uptake increases at a faster rate than dry Batter production with increasing fertilizer level as shown by Brockman (1966). These two factors are the major determinants for the crude protein content in the herbage. Figure 2 shows a rapid decline in the young heavily fertilized crops as an effect of dilution of the non protein matter incorporated at a later growth stage. The obtained nitrogen recovery rates are relatively small compared to figures quoted for temperate grass species, but not compared to figures obtained by Gartner (1966) working with tropical grasses. However, tropical grasses are notoriously low in protein. It is not clear to what extent this is intrinsic or a result of high potential yield of dry matter which occurred in these experiments or lack of other essential nutrients. It may also be mentioned that Oslen (1973) found that grasses in Uganda did not give a high yield response in crude protein similar to grasses grown in the humid tropics (Vicente-Chandler et al 1964), the reason-presumably being lack of rain in some periods; but whether this is also the case in the present study is uncertain.

There were virtually no effects of different nitrogen fertilizer level on the in vitro digestibility of organic matter at the first three cuts. The digestibility was about 60% for the crops from the fertilized treatments. For these early cuts there was a tendency to a lower digestibility with the herbage from the unfertilized plots, presumably due to a higher percentage of dead material. With advancing growth stages, the digestibility decreased steadily and approached the minimum of about 45%, irrespective of treatment.

The obtained digestibilities are similar to those compiled by Butterworth (1967) at various stages of maturity and found by Soneji, Musangi and Olsen (1971). As shown by McLeod and Minson (1969) one may expect that the in vivo digestibility would be 3-5 units higher than in vitro digestibility although comparison with reported results from other laboratories must be done with precaution (Barnes 1967)

The combined effects of increasing yield of dry matter and decreased digestibility (Figure 5) are the most relevant measures, together with the yield of crude protein, to evaluate the economic efficiency of nitrogen fertilization at various harvest dates.

Considering the fact that high digestibility will favour intake (Conrad et al 1964) one should expect better performance per animal eating the young crop. However, cutting the young crop results in relatively low yield. On the other hand, the high yield of a low digestible mature crop can sustain a greater number of animals. Both situations will no doubt improve the performance of the animal (Said 1971; Stobbs 1976) the latter being the most attractive under East African conditions with its large number of ruminants.

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Received 15 March 1980