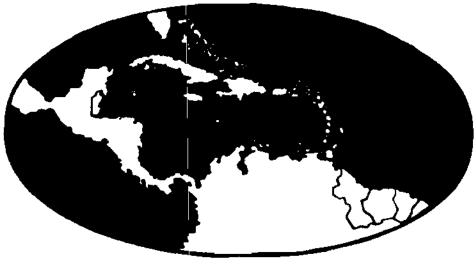
# CARIBBEAN FOOD CROPS SOCIETY



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# INFLUENCE OF NITROGEN FERTILIZATION AND HARVEST INTERVAL ON THE PRODUCTION OF TROPICAL GRASSES

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## ABSTRACT

Twelve tropical grasses (*Digitaria decumbens* (601), *Digitaria decumbens* (602), *Digitaria milanjiana* sub. sp. *eylesiana*, *Digitaria pentzii* (742), *Digitaria pentzii* (750), *Digitaria setivalva*, *Digitaria smutsii*, *Digitaria umfolozi*, *Hemarthria altissima* (993), *Hemarthria altissima* (995), *Brachiaria sp.*, and *Cynodon dactylon*) established in small plots on River Estate soil were given a low, moderate or high level of nitrogen fertilizer (as sulphate of ammonia) equivalent to a rate of 224, 448 or 672 kg N/ha/yr, and cut mechanically at either a short (4 week) or long (8 week) interval of re-growth. Herbage D.M. yields varied significantly between grass species ($P < 0.01$), and within grasses D.M. yields were increased significantly ($P < 0.01$) by increasing nitrogen fertilization. At the 8 week harvest interval yields of herbage D.M. were significantly higher ($P < 0.01$) than at the 4 week harvest interval. The response in D.M. production by these grasses tended to diminish with increasing level of nitrogen fertilization. Herbage crude protein contents were higher in grasses cut at the short harvest interval, but increased with increasing nitrogen fertilization at both ages of harvesting. The results are discussed in relation to the optimum utilization of nitrogen fertilizer by improved grasses in the Caribbean.

## INTRODUCTION

The predominant improved pasture grass of the West Indies has for more than two decades been Pangola grass (*Digitaria decumbens* Stent.). It is a fairly productive grass, aggressive, quite drought-resistant and is of a moderate nutritive value for ruminants (Osbourne, 1969). It has, however, been reported to be attacked by several insect pests and fungal diseases (Vicente-Chandler *et al.*, 1974) and also by a "stunt" virus disease (Dirven and Van Hoof, 1961). It was first introduced into the Caribbean around 1951 from the U.S.D.A. Oakes collection brought in from South Africa. A number of promising new grass species and varieties (or ecotypes) have since been developed from the genus - *Digitaria* (Oakes, 1965), and eight (8) of these together with two *Hemarthria* varieties (or ecotypes), a *Brachiaria* sp. and a hybrid of *Cynodon dactylon* have been subjected to a series of agronomic and nutritional studies initiated almost a decade ago at the University of the West Indies and continued up to the present time, as efforts continue to find alternative grasses of high productivity and quality especially for grazing and to reduce the heavy reliance on Pangola grass.

Since nitrogen is the nutrient which usually limits pasture productivity, and grass species differ in their response to nitrogen fertilization it is important to compare the performances of new grasses at varying nitrogen fertilizer levels in order to achieve efficient and optimum nitrogen fertilizer usage. Fertilizer studies with these grasses grown in small plots at the University Field Station (Cowlishaw, 1971) have shown almost linear responses in dry matter production to increasing nitrogen fertilization in all but a few of these grasses (e.g. *Hemarthria altissima*) when applied in the form of sulphate of ammonia up to a rate of 448 kg N/ha/yr and cut at 3 - 4 weeks of age. Other studies have investigated the effect on the nutritive value (IVOMD) of four of the *Digitaria* spp. of harvesting (cutting) at varying stages of regrowth (up to 8 weeks) and in different seasons (Miller, 1973), but no investigations were made of the interrelationship of nitrogen fertilization and age at harvesting on the productivity of these tropical pasture grasses. This paper presents some preliminary results taken from the first two month (8 week) period of a six month (24 week) study undertaken to examine the influence of level of nitrogen fertilization (up to a rate of 672 kg N/ha/yr and exceeding that of the earlier work) as well as harvest interval on the productivity and chemical composition of the twelve grasses used in the earlier studies.

## MATERIALS AND METHODS

The twelve grasses studied were:-

| | | |
|---|---|---|
| 1. | *Digitaria decumbens* | (USDA # 299601) |
| 2. | *Digitaria decumbens* | (USDA # 299602) |
| 3. | *Digitaria milanjiana* subsp. eylesiana | (USDA # 299742) |
| 4. | *Digitaria pentzii* | (USDA # 299742) |
| 5. | *Digitaria pentzii* | (USDA # 299750) |

| | | |
|---|---|---|
| 6. | *Digitaria setivalva* | (USDA # 299798) |
| 7. | *Digitaria smutsii* | (USDA # 299827) |
| 8. | *Digitaria umfolozi* | (USDA # 299892) |
| 9. | *Hamarthria altissima* | (USDA # 299993) |
| 10. | *Hamarthria altissima* | (USDA # 299995) |
| 11. | *Brachiaria* sp. | (USDA # SR 1487-1) |
| 12. | *Cynodon dactylon* | (USDA # SR 1485-1) |

All grasses were previously established in individual plots on River Estate loam soil at the University Field Station.

There were nine rows of plots, and each row consisted of twelve plots each of 18.5 sq. m in area to which was randomly allocated one of the grasses listed above. Within the row each grass (i.e. each plot) formed a main plot for the fertilizer treatments, and one half of each plot was cut after a short interval and the other half after a long interval of re-growth.

Three consecutive rows comprised one block, with a single grass species or variety (or ecotype) in each row being assigned at random to one of three levels of nitrogen fertilizer in the form of sulphate of ammonia (21% N). The treatments were replicated three times, and consisted of three levels of nitrogen fertilizer:

| | | |
|---|---|---|
| Low | - | equivalent to 224 kg N/ha/yr |
| Moderate | - | equivalent to 448 kg N/ha/yr |
| High | - | equivalent to 672 kg N/ha/yr |

each at two intervals of harvesting:

| | | |
|---|---|---|
| Short | - | 4 weeks of re-growth |
| Long | - | 8 weeks of re-growth |

The study commenced in January, 1974, with all grass plots being cut by an Allen Autoscythe reciprocating mower to a uniform height of 5 cm above ground level and fertilizer nitrogen applied immediately after cutting at the rate of 320 gms, 640 gms and 960 gms sulphate of ammonia fertilizer per plot to represent the low, moderate and high N fertilizer treatments. No irrigation was used during the study in spite of the fact that it was carried out during the dry period of the year.

Harvesting was done mechanically (as above) first after 4 weeks of re-growth for the short harvest interval, and then again after 8 weeks of re-growth for the long harvest interval. The area of the half-plot cut at each harvesting was 2.8 sq. m and the fresh herbage obtained from each grass was weighed for each plot. A sub-sample was then taken, dried for 24 hours at 100°C in a Unitherm forced-draught oven for dry matter determination, milled and kept for chemical analysis. The dry matter yield of the clipped area for each grass was computed and converted to a per hectare basis. The crude protein content of the herbage (N x 6.25) was determined on the sub-sample using the macro-kjeldahl procedure for the determination of nitrogen content.

The results were pooled for all grasses, and the data analysed statistically according to a split-plot arrangement of treatments using the method of Snedecor and Cochran (1967).

## RESULTS

The weather was relatively dry with a similar low level of precipitation recorded in each month, and the average monthly rainfall from January to March was 31 mm. The average daily air temperature for the same period was 24.7°C and typical of this period of the year.

The results for estimated herbage dry matter (D.M.) production per ha of the twelve grasses as affected by level of nitrogen fertilization and harvest interval (or age at cutting) are summarized in Table 1. The statistical comparisons of the effect of nitrogen fertilizer level, harvest interval and grass species, variety (or ecotype) are given in Table 2.

Mean herbage D.M. yields varied significantly ($P < 0.01$) between grasses with the highest yielding grasses (*H. altissima* and *D. decumbens* (601)) producing almost twice as much dry matter per ha overall as the lowest yielding species (*C. dactylon* and *D. pentzii*). Estimated mean herbage D.M. yields ranged from as low as 347 kg/ha for *Brachiaria* sp. when cut after 4 weeks of re-growth and only the low level of nitrogen fertilizer was applied up to as high as 7357 kg/ha for *Hemarthria altissima* (995) when harvested after 8 weeks of re-growth and given the high level nitrogen fertilization. Harvesting the grasses after an 8 week interval of re-growth, as expected, resulted in a significantly higher ($P < 0.01$) yield of dry matter (about 180%) as compared to harvesting after only 4 weeks of re-growth.

TABLE 1. **Effect of level of N fertilization on dry matter yield (kg/ha) of twelve tropical grasses harvested at 4 and 8 week stages of re-growth.**

| Grass Species | Grasses cut at 4 weeks of age | | | Grasses cut at 8 weeks of age | | | Grass Means |
|---|---|---|---|---|---|---|---|
| | Nitrogen fertilizer level | | | Nitrogen fertilizer level | | | |
| | Low | Moderate | High | Low | Moderate | High | |
| *D. pentzii* 299742 | 1002 | 1235 | 828 | 2176 | 3268 | 3692 | 2034 [bc] |
| *H. altissima* 299995 | 933 | 1438 | 2274 | 4120 | 6087 | 7357 | 3702 [a] |
| *D. decumbens* 299602 | 1039 | 1993 | 2064 | 3404 | 5734 | 5377 | 3268 [a] |
| *D. milanjiana* Sub. sp. eylesiana 299730 | 1541 | 1447 | 1623 | 3246 | 4987 | 4813 | 2943 [b] |
| *Brachiaria sp.* SR 1487 | 347 | 1074 | 1368 | 4563 | 4181 | 3822 | 2559 [b] |
| *D. smutsii* 299827 | 991 | 1240 | 2140 | 2010 | 4721 | 4500 | 2600 [b] |
| *D. pentzii* 299750 | 1322 | 2504 | 2907 | 4358 | 4149 | 5782 | 3504 [a] |
| *D. decumbens* 299601 | 1250 | 1936 | 3755 | 4597 | 4895 | 5578 | 3669 [a] |
| *H. altissima* 299993 | 1199 | 2273 | 1806 | 4353 | 5370 | 7094 | 3882 [a] |
| *D. umfolozi* 299892 | 1058 | 922 | 1675 | 2202 | 3931 | 3481 | 2611 [b] |
| *D. setivalva* 299798 | 1025 | 1801 | 2110 | 2974 | 3558 | 4252 | 2620 [b] |
| *C. dactylon* SR 1485-1 | 783 | 1275 | 1821 | 2146 | 3580 | 4217 | 2306 [bc] |
| | | | | | | | SED ± 333 |

SED = Standard Error of Difference

This paper is intended only to examine overall trends, but it is obvious that certain individual grasses included in this study are capable of very efficient utilization of nitrogen fertilizer in the production of dry matter (e.g. *Brachiaria* sp.) while others (e.g. *Hemarthria altissima*) may be potentially high-producing but do not respond to heavy applications of nitrogen fertilizer with linear increases in D.M. yield. These findings support the work of Adigun (1973) with three of the grasses used.

The D.M. yields observed in this study were similar to those obtained by Cowlishaw (1972) with the same grasses when given up to 448 kg N/ha/yr, and the trends in response to increasing nitrogen fertilization were similar. But, this study further demonstrated the ability of several of the grasses to utilize nitrogen fertilizer well up to a rate of almost 700 kg N/ha/yr, and even more important, significant yield responses to increased nitrogen fertilization were obtained when the grasses were cut after 8 weeks of re-growth. Most of the earlier studies used 3 - 4 week harvest intervals, but it does appear that during the dry season a longer harvest interval is necessary for optimum utilization of fertilizer nitrogen. This is particularly evident from the age x grass and age x nitrogen interactions. Further study of these interactions from the data is to be made statistically for a more comprehensive presentation of the full (six month) study.

The response in additional herbage dry matter in quantitative terms within grasses by increasing nitrogen fertilization indicates that at the 8 week harvest interval nearly twice as much additional herbage D.M. was produced per ha for each additional 1 kg of nitrogen applied as fertilizer up to the rate of 672 kg N/ha/yr (13.4 vs. 22.3 kg D.M.). But this difference in yield response came largely from the response obtained up to the moderate level of N fertilization (32 kg D.M.). While, the yield response in dry matter at the 4 week harvest interval tended to be linear up to the high level of nitrogen fertilization. These results suggest that when the long harvest interval is used there may be no need to apply sulphate of ammonia fertilizer at a rate higher than 448 kg N/ha/yr during the dry season.

In relation to herbage crude protein content as an index of herbage quality (Miller, 1973) it is of interest that within grasses herbage C.P. content fell by over 30% at the long harvest interval. However, a similar improvement in herbage C.P. content was achieved by increasing levels of nitrogen fertilization at both harvest intervals. It would appear that in respect of herbage crude protein output per ha that similar or slightly higher quantities would be produced in the herbage D.M. during the dry period of the year by using the short (4 week) harvest interval.

**TABLE 2. Effect of nitrogen fertilizer level and harvest interval on herbage D.M. production (kg/ha) (and crude protein content (%, D.M. basis)) of twelve tropical grasses.**

| | | Nitrogen Fertilizer Level | | | |
|---|---|---|---|---|---|
| Harvest Interval | n | Low | Moderate | High | Harvest Interval Means |
| 4 Week | 36 | 1,041 | 1,595 | 2,031 | 1,555 [a] |
| | | (10.9) | (11.9) | (12.6) | SED |
| 8 Week | 36 | 3,346 | 4,538 | 4,997 | 4,294 [b] ± 110 |
| | | (6.2) | (6.8) | (8.3) | |
| N fert. means | | 2193[a] | 3067[b] | 3514[c] | |
| | | | SED ± 166 | | |

SED = Standard error of difference

n = Number of observations per treatment

Herbage crude protein content - figures in parenthesis

Within grasses increasing the level of nitrogen fertilizer applied significantly ($P < 0.01$) increased herbage D.M. yield, but the response tended to decline with increasing level of nitrogen fertilization giving a 42% higher yield at the moderate level and only 59% higher production at the high level of nitrogen fertilization than when the low level of nitrogen fertilizer was used.

There were no significant grass x nitrogen interactions, and although considerable variation in response to nitrogen fertilization was observed between grasses the pattern of response was relatively consistent. However, within nitrogen fertilizer levels highly significant differences ($P < 0.01$) were observed between grasses in D.M. yield at each harvest interval indicating a grass x age interaction. Also, within grasses there were significant differences in herbage D.M. production ($P < 0.05$) between varying levels of nitrogen fertilization and harvest intervals due to an age x fertilizer nitrogen interaction. But, no grass x age x nitrogen interaction was observed.

Regarding herbage crude protein content no statistical comparisons are included. However, the crude protein contents of the grasses were as expected, considerably higher in the herbage cut at 4 weeks (11.8%) than that cut at 8 weeks (7.1%) of re-growth. Also, herbage crude protein content increased with increasing level of nitrogen fertilization from 10.9% to 12.6% on average at the 4 weeks harvest interval and from 6.2% to 8.3% on average at the 8 week harvest interval (Table 2).

## DISCUSSION

It has not been customary to use very high applications of nitrogen fertilizer (over 448 kg N/ha/yr) in this country to maximise pasture yields and to increase carrying capacity. The results of this study indicate that with most improved tropical grasses tried here responses in herbage D.M. production and quality (C.P. content) should be sufficient to promote higher animal output from ruminants both per animal and per unit area of land. However, it does appear from the curvilinear nature of the production response under the soil and climatic conditions experienced here that the upper limit for nitrogen fertilization when sulphate of ammonia is used is being approached.

The climatic conditions experienced were typical of the dry, cool season of the year when grass growth is slow. However, a significant response in herbage D.M. yield was observed up to the rate of 672 kg N/ha/yr. In Puerto Rico, Vicente-Chandler *et al.*, (1974) reported a considerably diminished response in the yield of most grasses (except *Pennisetum purpureum*) above 400 kg N/ha/yr during the period between December and March.

The results of this study are encouraging and should be repeated under wet season conditions. In addition, studies of the utilization of the most promising of these grasses by grazing and/or zero-grazing should be undertaken, and it may be advisable to use a 6 to 8 week interval of harvesting during the dry season in this country.

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