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A Study of the Effect of Nitrogen Fertilization and Intensity and Frequency of Defoliation on Yield, Chemical Composition and Feeding Value of Guinea A Grass

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Abstract : Two experiments were carried out to investigate the influence of intensity and frequency of defoliation and N application on dry matter yield, chemical composition and feeding value of Guinea A grass, found abundantly in the low and mid-country of Sri Lanka. In Experiment I, the effect of three cutting heights on dry matter yield, crude protein percentage and digestibility, were investigated. When harvested at 30 day intervals under a fertilizer regime of 336 kg N/ha/year, the height of cutting had a significant influence on herbage dry matter yield and leaf : stem ratio. It had no effect however, on crude protein percentage and *in vitro* organic matter digestibility. In the second experiment, the influence of three levels of N, on changes in composition and feeding value, when harvested at 15, 30 and 45 days, was studied. N application up to 84 kg N/ha/year had no significant effect on dry matter yield but the crude protein content increased with age up to 30 days and declined thereafter. An inverse relationship was seen between herbage dry matter yield and its feeding value. It is concluded that Guinea A grass shows no response to N application up to 84 kg N/ha/year and that highest dry matter yields can be achieved when defoliated to a height of 6″ above ground level at 30 day intervals ; the harvested material having 13 to 14% crude protein and an organic matter digestibility of 53%.

1. Introduction

Guinea grass, also known as Guinea A (*Panicum maximum*, ecotype A) found abundantly in low and mid country of Sri Lanka, is extremely resistant to drought and prolific in growth. Despite recommendations for the use of improved varieties, dairy farmers in these areas utilize Guinea A as the main source of roughage for their cattle. The recent trend has therefore been to treat Guinea A as a useful source of fodder rather than attempting to eradicate and replace it with improved varieties.

It is now well established that high nitrogen application increases herbage dry matter yields and enhances herbage quality.[1,7,8,9] Recently, Jayawardene[6] demonstrated that Guinea A responds well to the application of 250 kg N/ha by producing 26,000 kg dry matter/ha having a crude protein content of 11%, when harvested at six weekly intervals. High nitrogen application to grass-land would, however, be uneconomical in view of the rising cost of fertilizers and shortages experienced from time to time.

The intensity and frequency of defoliation has also been demonstrated to influence the rate of regrowth and hence the output of herbage dry matter/unit of land.[1,4,5,10]

This paper reports the results of two field experiments designed to study the influence of low levels of nitrogen and intensity and frequency of defoliation on dry matter yield, composition and feeding value of Guinea A grass. The experiments were conducted at the Pasture Research Unit of the Department of Animal Husbandry, University of Sri Lanka, Peradeniya Campus, during February to July 1977.

2. Materials and Methods

Experiment I.

Guinea A grass was established in the field about six months prior to the commencement of the trial. The layout of the trial was a completely randomized block design with four replications. The size of the main plot was 10′ × 6′ and each sampling sub-plot measured 6′ × 4′. Grass was planted giving a spacing of 2′ × 2′. Prior to the actual commencement of the trial all plots were fertilized uniformly with a basal application of 112 kg K_2O and 56 kg P_2O_5/ha.

Three cutting heights, namely 1″, 3″ and 6″ above ground level, were studied. The plots were harvested at monthly intervals to estimate the herbage yield. The total period of sampling was 90 days. At the beginning and after each harvest, nitrogen was applied in the form of urea at the rate of 336 kg nitrogen/ha/year and worked into the soil by forking. The experiment commenced on the 28th April 1977.

At each sampling herbage was cut to the appropriate height as at the commencement, mixed thoroughly, weighed on the spot and two sub-samples were removed to the laboratory. One sub-sample was entirely used to determine the leaf : stem ratio and the Leaf Area Index (LAI). The other sample was used for dry matter determination.

Experiment II.

Guinea A grass was established in the field about 3 months prior to the actual commencement of the trial. The experiment was laid out as a 3 × 3 factorial with four replications. Each main plot measured 10′ × 6′ and the sampling sub-plot measured 6′ × 4′. The plants were evenly spaced at a distance of 2′ × 2′. Prior to the commencement of the trial all plots were uniformly cut to a height of 6″ above ground level. In addition all plots were fertilized uniformly with a basal application of 112 kg K_2O and 56 kg P_2O_5/ha.

Nitrogen was applied in the form of urea. Three rates of application, namely 0, 56 and 84 kg Nitrogen/ha/year were compared. The appropriate quantity of nitrogen fertilizer was placed around each plant after harvest and incorporated into the soil by forking.

Since the main purpose of the study was to observe the changes in composition and feeding value during uninterrupted growth within a cutting cycle of 45 days, sampling was done at 15, 30 and 45 days, each time removing the cumulative growth from the time of previous sampling. At each sampling, the herbage was cut to 6″ from ground level as at the commencement, mixed thoroughly and a sub-sample removed to the laboratory for dry matter determination. The experiment commenced on the 18th February 1977.

Laboratory Methods

For both experiments the dry matter determination was carried out by drying the sub-sample in an unitherm oven at 100°C for 6 hours. A representative sample from each of these was used for the determination of crude protein by Kjeldhal method and *in vitro* organic matter digestibility by the method of Tilley and Terry.[11]

3. Results

Experiment I

The influence of height of cutting, on the composition and feeding value of Guinea A is shown in Table 1.

TABLE 1. The influence of height of cutting on composition and feeding value of Guinea A. (The values are the mean of three harvests).—Experiment I.

Height of cutting (inches)	1	3	6	S.E. of difference for comparing means.
The mean herbage dry matter yields (kg/plot)	1.05	1.18	1.29	± 0.06
Percentage dry matter	19.4	19.5	20.2	± 0.34
Crude protein content (g/100 g dry matter)	12.9	14.4	14.1	± 0.63
Leaf : stem ratio	1.34	1.68	2.20	± 0.18
Leaf area index (LAI)	4.9	5.5	5.7	± 0.34
In vitro organic matter digestibility (%)	51.1	47.7	49.5	± 1.52

The height of cutting appeared to have a significant effect upon the herbage dry matter yield. Increasing the height of cutting from 1 ″to 6″ increased the herbage dry matter yields significantly ($P < 0.05$). Although it had no influence on the dry matter percentage, it increased the leaf : stem ratio significantly ($P < 0.05$). The cutting height of 6″ gave the highest leaf : stem ratio of 2.2 at 30 days of growth.

With the increase in the leaf : stem ratio the LAI also increased ; however, beyond the cutting height of 3″ there was no further significant ($P < 0.05$) increase in the LAI.

Even though the height of cutting influenced the dry matter yield, it had no effect on the crude protein percentage and the *in vitro* organic matter digestibility.

Experiment II

The mean yields of herbage dry matter at each sampling date (mean cumulative growth) for the 45 days of growth are shown in Table 2. Nitrogen application up to 84 kg/ha had no significant ($P < 0.05$) effect upon the yield of dry matter. However increasing the cutting frequency increased dry matter yields significantly ($P < 0.01$) at all levels of nitrogen.

TABLE 2. Mean herbage dry matter yields in grams per plot—(cumulative growth)—Experiment II.

Days of growth	15	30	45
Nitrogen application (kg/ha)			
0	157	431	729
56	184	477	609
84	197	438	531

S.E. of difference for comparing any two nitrogen levels at the same harvesting date $\pm$ 58.9

S.E. of difference for comparing any two harvesting dates at the same nitrogen level $\pm$ 58.9

S.E. of difference for comparing interactions $\pm$ 144.2

Table 3 shows the mean crude protein percentage in herbage dry matter at each sampling date. The crude protein percentage increased significantly with age up to 30 days and thereafter showed a rapid decline. Increasing the dosage of nitrogen from 0 to 56 kg nitrogen/ha increased the crude protein percentage ; beyond 56 kg nitrogen there was no further increase. As could be expected, the mean herbage dry matter percentage increased with advancing maturity but nitrogen application had no significant effect. (Table 4).

TABLE 3. Mean crude protein percentage in herbage dry matter—Experiment II.

Days of growth	15	30	45
Nitrogen application (kg/ha)			
0	10.67	13.17	9.92
56	11.72	13.20	11.67
84	11.67	13.12	10.47

S.E. of difference for comparing any two nitrogen levels at the same harvesting date $\pm$ 0.26

S.E. of difference for comparing any two harvesting dates at the same nitrogen level $\pm$ 0.26

S.E. of difference for comparing interactions $\pm$ 0.64

TABLE 4. Mean herbage dry matter percentage—Experiment II.

Days of growth	15	30	45
Nitrogen application (kg/ha)			
0	25.19	24.33	28.81
56	24.69	27.23	28.85
84	22.76	24.64	30.10

S. E. of difference for comparing any two nitrogen levels at the same harvesting date ± 2.19

S.E. of difference for comparing any two harvesting dates at the same nitrogen level ± 2.19

S.E. of difference for comparing interactions ± 5.36

The relationship between dry matter yield (DMY) and *in vitro* organic matter digestibility (IVOMD) with increasing maturity of the herbage is shown in Figure 1. There was an inverse relationship between herbage yield and its feeding value. As the plants progressed towards maturity, herbage yield increased but the organic matter digestibility declined.

4. Discussion

Pasture management is aimed at securing the highest output/unit of land of good quality herbage, that can be used for the successful raising of livestock. Intensive pasture management therefore involves the production of high yields/unit of land of herbage of high feeding value and the efficient use of the herbage produced. In this context increasing attention has been paid in recent years to the study of the influence of intensity of defoliation on herbage growth. The results of the present experiments clearly demonstrate that Guinea A fodder yields the highest quantity of herbage dry matter when defoliated to a height of 6″ above ground level and at 30 day intervals.

The variation in yields with the intensity of defoliation can be attributed to two main factors. As claimed by Watson[12,13] it could be primarily due to changes in leaf area, which would operate directly by altering the photosynthetic area and indirectly by changing the net assimilation rate. The relationship between leaf area and pasture yields was clearly demonstrated by Brougham,[3] who reported that the height of defoliation markedly influenced the rate of regrowth. The stage at which 95% of the incident light energy was intercepted and hence a maximum rate of regrowth attained, corresponded to a leaf area index of 5 and following defoliation to a height of 5″ above ground level, this was achieved approximately 4 days after cutting, whereas regrowth did not reach a maximum rate until 16 and 24 days following defoliation to 3 inches and 1 inch, respectively. Beyond this point the rate of increase in leaf area and the increment in dry matter was maintained at a maximum rate. Thus it seems that defoliation to a height of 6″, induced Guinea A grass to attain the optimum LAI very rapidly resulting in the maximum rate of regrowth producing the highest dry matter yields.

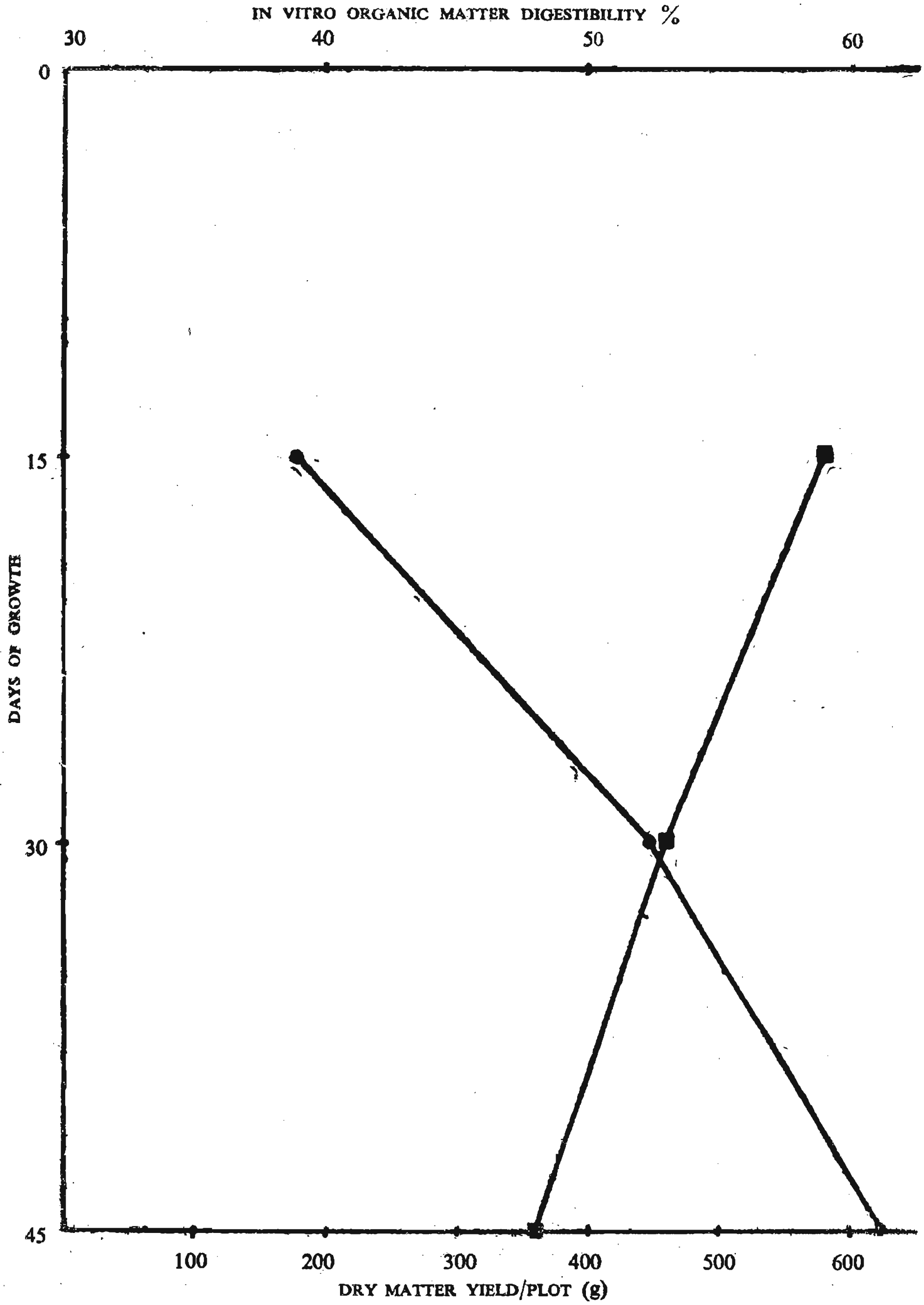

Figure 1. The relationship between dry matter yield and *in vitro* organic matter digestibility of Guinea A grass.

■———■ IVOMD

o———o DMY

The effect of defoliation on water absorption could have also influenced the high dry matter production at the 6″ cutting height. According to Army and Kozlowski,[2] the effect of soil moisture is more severe on closely defoliated plants than on lax defoliated plants. In lax defoliated plants, transpiration occurs and causes a diffusion pressure deficit in the leaves, which may be transmitted as a tension to the roots and helps to absorb water. If the plants are closely defoliated, however, they will have to depend only on the absorption mechanism of their roots for the water supply, thus limiting rate of regrowth.

Pure stands of grass are known to respond readily to applied nitrogen. However, the results of the present investigation indicate that Guinea A grass does not respond to applied nitrogen up to 84 kg/ha. It may be possible that the quantities investigated in the reported trial were too low to produce any significant response. On the other hand, microorganisms associated with the root rhizosphere of Guinea grass could have influenced nitrogen utilization. It has been clearly demonstrated that microorganisms associated with root hairs of most tropical grasses are capable of fixing atmospheric nitrogen similar to legumes.[14] The equal response in dry matter production at 0, 56 and 84 kg/ha in the present trial is strongly indicative of such an association between the plant and the soil borne microorganisms.

Rainfall enhances the rapid growth of pasture grasses. Drought conditions on the other hand, results in reduced rate of growth, early maturity and early flowering. This is often reflected in the feeding value of the pasture herbage especially in the rate of decline of crude protein content and nutritive value. The more suitable climate conditions (Appendix Table 1) experienced during the experimental period could have therefore been responsible for the high crude protein and the dry matter yields recorded.

APPENDIX TABLE 1. Weather Data (January—July 1977)

Month	Monthly rainfall (mm)	Temperature (°F)		Relative Humidity (%)	
		Minimum	Maximum	Morning	Evening
January	2.8	61.7	84.2	72.9	53.6
February	6.7	67.1	86.0	73.8	55.2
March	123.1	69.8	87.8	75.6	60.6
April	291.1	68.9	89.6	84.0	73.5
May	450.8	69.8	83.3	82.6	83.3
June	174.0	68.9	81.5	80.8	73.4
July	76.5	68.9	84.2	81.6	73.8

(Source—CARI—Department of Agriculture, Gannoruwa)

The present investigation confirms the inverse relationship that exists between dry matter production and feeding value of pasture herbage (Figure 1). The choice of the optimal stage of defoliation would involve a compromise between these two factors. A late defoliation would result in a higher dry matter production but low feeding value while the reverse would be true for early defoliation. Thus the compromise between yield and quality of Guinea A when defoliated to a height of 6" above ground level, appears to be around the 30th day at which time it yields around 24,000 kg dry matter/ha, having a crude protein content of 13 to 14% and an *in vitro* organic matter digestibility of 53%.

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