A Study of the Effect of Nitrogen Fertilization and Frequency of Defoliation on Yield, Chemical Composition and Nutritive Value of Three Tropical Grasses*

T. SIVALINGAM

Agricultural Research Station, Mahaillıppallama, Ceylon

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PASTURES and fodder grasses in the tropics have a high yield potential accompanied by poor quality. Heavy application of nitrogen or a mixed cropping of grass with a suitable legume is found to enhance productivity, and to improve the quality of the forage. The prominent absence of a suitable pasture legume, equal in status to a temperate one, has been a stumbling block in this direction. The long and well marked dry season, coupled with a high soil temperature of the dry tropics apparently does not favour a mixed sward. The aggressiveness of the growth of tropical grasses also operates against the efficient association of legumes with grasses.

In view of the difficulties encountered with pasture legumes in this climate, it is customary to resort to the use of fertilizers, mainly the nitrogenous ones, to enhance the productivity and the nutritional value of the forage. There are numerous instances of high productivity, both in quantity and quality engendered by the prolific use of nitrogenous fertilizers (8 and 16). The quick depletion of the nitrogenous reserve in the soil by intensive cropping compels augmentation of this element (16). Since the pattern of pasture productivity in the dry zone of Ceylon is bimodal, (due to the similar pattern in the distribution of precipitation) heavy application of nitrogen at the peak seasons of growth will also increase the production of excess forage, which could be conserved for use in the lean season.

An experiment on different levels of nitrogen and cutting frequencies on Napier (*Pennisetum purpureum*), Guinea *Panicum maximum*), and Brachiaria (*Brachiaria brizantha*), was carried out for a period of three years at the Agricultural Research Station, Maha-Illuppallama. Only the results of two years are discussed here. The

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experiment was located on a soil type, representing the lower members of the soil catena, which is well drained in the dry season and imperfectly drained at the peak of the wet season (2).

1. **Pennisetum purpureum—Schumach—Napier**

A perennial tall growing grass, growing to about 8 to 10 ft. in height. Propagated by sets, slips or cuttings. The stem when fully matured is hard, fibrous and slightly sweet in taste. When this grass is fed in the barn, the unpalatable matured stems are discarded by cattle. Due to its growth habit it is generally a soilage type. It cannot withstand grazing even at the early stages of growth due to the damage caused by trampling.

2. **Panicum maximum—Jacqr—Guinea**

Tall growing tufted perennial with a shallow root system. Fairly drought resistant, but will not tolerate long period of dessication. Grows to about five feet in height and vegetation becomes coarse with time due to maturity and incidence of profuse flowering. Seeds are produced in abundance, and they have a medium viability. Establishment by seed is possible but time consuming. Propagation by sets gives a quick and uniform stand. This grass has a high tiller count with about 60 to 75 productive tillers. This grass is termed as a soilage type, essentially due to its growth habits. Light grazing could also be practised without causing much damage to the clumps.

3. **Brachiaria brizantha—(Hochst) stapf—Brachiaria**

A highly productive grass with a high adaptability in this country. It grows to about three feet in height and is semi-erect in growth. The quick growth habit, coupled with an efficient rooting system has made it ubiquitous in this country. Due to its aggressiveness it soon forms a dense vegetation which in turn increases the leaf area index. This nature of growth will hardly tolerate any associates, such as weeds or legumes, indefinitely. Due to the free rooting habit the quantity of roots produced per unit area is large, hence a large absorptive area. The roots were observed to go even deeper than four feet to exploit the untapped source for nutrients and moisture. It flowers freely producing conspicuous flower heads. The setting of seeds and their viability are observed to be meagre. Due to poor setting of seeds, propagation is necessarily by stem cuttings. This grass has a remarkable forage quality as it withstands grazing and cutting equally well with an efficient recovery.

EXPERIMENTAL METHODS

A split-split plot design was employed in the experiment. Grasses formed the main plots, Cutting frequencies the sub plots and nitrogen levels the sub-sub plots. The treatments were replicated thrice. The sub-sub treatment plots were 24 x 8 feet in dimension and had a broad border of three feet between plots. All treatments were randomised.

The grasses—Napier, Guinea and Brachiaria were planted in the previous season at a spacing of $1\frac{1}{2} \times 1\frac{1}{2}$ feet. The different frequencies of defoliation were 30, 60, and 90 days. The nitrogen levels were 0, 40, 120 and 360 pounds of nitrogen per acre per year applied in the form of Sulphate of Ammonia. Nitrogen was applied in three split doses, in October, December and April. A blanket application of 2 cwt. of Single Superphosphate and one cwt. of Muriate of Potash was applied each year in two splits, one in October and the other in April. Harvesting was done by sickles, leaving four inches of vegetation above ground. The harvests were weighed at the spot. A catch sample was taken for moisture determination and for other laboratory evaluations. Moisture percentage was determined after eight hours of drying at 100°C in a Unitherm Dryer. The samples after moisture determination were passed on for evaluating crude protein, crude fibre, ether extract, total ash by standard methods. Chemical analyses were carried out from samples obtained by mixing the replicates together.

Digestible nutrients were calculated using standard equations suggested by Bredon, Harker and Marshall (5). Percentage of recovery and utilization efficiency of the applied nitrogen were calculated from the nitrogen figures obtained by Kjaldhal process. The dry matter figures were statistically analysed, separately for each year.

RESULTS

Quantity of Forage

The chief criterion in estimating the potential of grasses quantitatively, is the dry matter yield. Among the grasses tested Brachiaria gave the highest dry matter yield. The total dry matter yields were 20,133 ; 15,288 and 14,914 pounds per acre per year for Brachiaria, Napier, and Guinea respectively. Brachiaria gave an increase of 4,905 pounds of dry matter over Napier. The difference in yield between Napier and Guinea was only 314 pounds of dry matter.

The relationship between the levels of nitrogen applied and dry matter yield was linear. The dry matter yield of Napier and Guinea at 360 N level of fertility was more than double that at zero nitrogen level. In Brachiaria, the dry matter yield at 360 N level registered an increase of 77.5 per cent. over the zero level of nitrogen. The behaviour of Brachiaria in relation to cutting frequency was completely different from that of Guinea or Napier. At 30 days cutting frequency Brachiaria produced 21,072 pounds of dry matter per acre. The other two grasses yielded only half this quantity of herbage at this frequency of defoliation. The average yield of Brachiaria showed no increase with the increase in intervals between defoliations. The yields of Napier and Guinea on the other hand showed a marked increase with longer intervals between defoliations. The highest yield of these two grasses was obtained under the 90-day cutting interval (Table 2 and Graph 1). There was a distinct decrease in the dry matter yields from the first to the second year. This decrease was evident at all levels of nitrogen application, including zero level. The decrease was marked at the lower levels of nitrogen application and under more frequent defoliation (Table 2 and Graph 1).

Quality of Forage

Although the tonnage produced limits the carrying capacity of pastures in the first instance, their chemical and nutritive values can be equally limiting. Fernando and Sivalingam (9) have reported that cattle in poor quality pasture but with sufficient forage, spent more time in gathering their requirements than in a sward well balanced in quantity and quality. Cattle have been found to be selective in grazing and they consumed 23 per cent. more of proteins and 16.8 per cent. less of crude fibre than the corresponding values indicated by the chemical analysis of the offered herbage (14). Hence, judging the values of a pasture on the basis of total yield of dry matter alone can be quite misleading. The feeding values of herbage must also be taken into account.

Crude Protein

Brachiaria gave the highest crude protein yield in both years, excelling Napier and Guinea which differed little from each other in this respect. There was a drop in crude protein yield from the first to the second year, concomitant with the drop in dry matter yield. The yield of crude proteins diminished with increase in the intervals between cuttings. The crude protein yield at 30 days cutting frequency was nearly double that obtained under 90 days cutting frequency. Fertilizer nitrogen increased the amount of crude protein (Graph 2).

Crude Fibre

In both years the trends exhibited by the crude fibre content were the reverse of the trends observed for crude protein. Crude fibre increased with longer intervals between defoliations, and decreased with increasing nitrogen levels. The fibre content was the highest in Napier and lowest in Guinea, and in Brachiaria it was intermediate.

Ether Extract

This was lower in Guinea than in other two grasses. Heavy nitrogen application increased the ether extract slightly.

Total Ash

The mineral fraction of the herbage is represented by the total ash content. It was highest in Napier and lowest in Brachiaria. It was found to decrease slightly with less frequent defoliations, while higher levels of nitrogen application resulted in a slight increase.

Nutritive values of forage are rated by the amount of digestible nutrients available. The digestible fraction of the main yield was calculated in terms of digestible crude protein, digestible dry matter, starch equivalent and total digestible nutrients (5).

Digestible Crude Proteins

The picture presented by the data on digestible crude proteins is closely similar to that presented by total crude protein (Graph 2). Digestibility is more influenced by the frequency of defoliation than by different levels of nitrogen. The digestibility of proteins falls rapidly as the intervals between cuts increase from 30 to 90 days. Digestibility of crude protein in 90 day old herbage is less than 25 per cent., while in 30 day old herbage it exceeds 50 per cent. of the total. The effects of different levels of nitrogen on protein digestibility were more pronounced with shorter intervals between defoliations than with longer intervals.

Digestible Dry Matter

This gives the same trends as observed in case of other digestible nutrients. With shorter intervals between defoliations, greater digestibility has been the rule. Napier and Guinea gave comparatively low dry matter yields at 30 days of defoliation but the quality of the forage goes a long way towards compensating for the poor yield.

Starch Equivalent

This expresses energy value, digestibility being interpreted in terms of pure starch taken as a constant (17). Total starch equivalent follows a similar pattern as total protein yields. Energy value is thus associated with the quality of the material. The average of two years data calculated in terms of starch equivalent gives a lucid representation of the factor under discussion (Graph 2). Brachiaria cut at 30 day intervals and associated with high nitrogen levels gave the highest values for starch equivalent. The values of starch equivalent were influenced to a greater extent by the frequencies of defoliation than by the different levels of nitrogen.

Total Digestible Nutrients

The TDN values are directly proportional to the starch values. The pictorial representation (Graph 1) which includes the total dry matter yield, total starch equivalent, and the total digestible nutrients gives a clear representation of the uniform variability of TDN from the starch equivalent values.

Ratio of Digestible Crude Proteins to Starch Equivalent

Table 5 gives the ratio of calculated digestible crude proteins to starch equivalent. This ratio increases with increase in the intervals between defoliations. Nitrogen fertilization reduces the ratio. The highest ratio occurs at zero level of nitrogen and 90 day frequency of defoliation.

RECOVERY OF THE APPLIED NITROGEN

Grasses in the present study recovered on an average 61 per cent. of the applied nitrogen. The highest percentage of recovery (68 per cent.) was obtained at 120 N level, while the lowest recovery (50 per cent.) occured at 360 N. The grasses differed in the recovery of the applied nitrogen. The highest recovery was by Brachiaria. Guinea was only slightly inferior in this respect. Napier registered the distinctly poorer recovery. All grasses showed highest recovery at 120 N, except Guinea which had the highest recovery at 40 N level. Different frequencies of defoliation did not markedly affect the recovery of the applied nitrogen. At 30 days frequency of defoliation the recovery was slightly better than with less frequent defoliation.

The results of two years indicated that there was a reduction in the recovery of the applied nitrogen in the second year. Napier and Guinea showed a decline of 37 per cent. in the second year and Brachiaria 43 per cent. This decline was associated with the depletion of soil reserve of nitrogen.

NITROGEN UTILIZATION EFFICIENCY

Nitrogen utilization efficiency is rated by the amount of dry matter produced per pound of nitrogen applied. It varies widely between different grasses, between nitrogen levels and under different frequencies of defoliation. Guinea gave the highest return of dry matter (46.57 lbs.) per pound of nitrogen applied. Brachiaria was the second in order of efficiency of nitrogen utilization, giving 42.31 pounds of dry matter per pound of nitrogen. Napier gave only 33.09 pounds of dry matter in this connection.

Cutting frequency significantly influenced the efficiency of nitrogen utilization. With Napier and Guinea maximum efficiency in nitrogen utilization was obtained with a cutting frenqency of 90 days, which coincides with highest dry matter yield. Similarly Brachiaria exhibited maximum efficiency under a 30 days cutting frequency. Nitrogen utilization efficiency, in relation to different levels of nitrogen applied, was highest at 120 N.

DEPLETION OF SOIL NITROGEN

Nitrogen for plant growth is available from the applied nitrogen or from the soil reserve of nitrogen. The data in the present study suggest that grasses tap the soil reserve of nitrogen if the applied nitrogen is not adequately available at the root zone. Soil nitrogen utilization at zero pounds nitrogen per acre ranged from 72.28 to 210 pounds of nitrogen in the first year, and from 58.06 to 119.2 pounds of nitrogen in the second year. (Table 4). There was a tremendous decrease of nitrogen in the dry matter in the second year. This decrease was more marked under more frequent defoliations. Brachiaria tended to deplete soil nitrogen to a much greater extent than Napier or Guinea.

Effect of Heavy Application of Ammonium Sulphate on the pH status of Soil

There was a drop of one unit in pH at the highest level of nitrogen fertilizer application. This drop was recorded after a period of two years of study. At the lower levels of nitrogen application the soil acidity did not decrease appreciably.

DISCUSSION

Brachiaria gave the highest yields and the most rapid growth among three grasses tested in this study. While the vitality and productivity of the two tall growing grasses Napier and Guinea were greatly reduced by more frequent defoliation, a reduction in the interval between cuts from 90 to 30 days did not depress the total annual productivity of Brachiaria. The latter is clearly a more vigorous grass than Napier or Guinea, and this combined with its low spreading habit makes it the only one of the three grasses tested which is suited for grazing conditions in the dry zone.

Cutting treatments do not give completely accurate information on the pasture, from the standpoint of utilization, due to the 'selectivity' exercised by the grazing animals. The forage selected by grazing animals on poor but abundant pasture is considerably richer in protein and fat, and poorer in fibre than the 'herbage offering' on such swards (13). Cutting experiments, while providing indications regarding the effects of various factors on the chemical composition and nutritive value of the herbage, can be used as an acurate guide in regard to the feeding value of pasture under grazed conditions only where due allowance is made for 'selective grazing'.

In the present experiment higher levels of nitrogen application and more frequent cuttings resulted in herbage of distinctly higher quality. Improvement in quality was closely associated with the increase in the crude protein content of the herbage. The fat and ash content of the herbage was positively correlated with, and the crude fibre content negatively correlated with, the protein content of the herbage. These findings are in accord with work elsewhere (14 and 15), and assessment of herbage quality may thus be restricted to crude protein alone.

Two important indices of nutritive value, viz., starch equivalent and total digestible nutrients, were also found to be closely correlated with crude protein content of the herbage. Optimum utilization of herbage, i.e., maximum conversion of grass to meat and milk, is also dependent on the occurrence of the correct ratio of digestible crude protein to starch equivalent in the daily feed intake. Under tropical conditions Bredon and Horrel (3) have indicated that a ratio of the order of 1 : 12 is adequate. On this basis the data in the present study suggest that all the grasses tested provide satisfactory 'balanced' feed when cut at 30 days intervals and fertilized with at least 40 pounds nitrogen per acre. There is a rapid increase in the ratio (and therefore a rapid decline in feeding value) with less frequent defoliation. Where the cutting interval is 60 or 90 days the use of protein supplements is thus necessary if the optimum ratio of digestible protein to starch equivalent is to be maintained in the daily feed. Brachiaria is consequently the best grass under local conditions, since maximum production of dry matter coincides with maximum feeding value, and there is no need to incur expenditure on expensive protein supplements in an effort to maximize herbage utilization and meat/milk production.

The recovery of the applied nitrogen was about 61 per cent. in all grasses. This figure is fairly high in comparison with the percentage figures obtained by Andrade and co-workers in Costa Rica (1). At Puerto Rico, tropical grasses were found to recover only half the amount of nitrogen applied, even under the best system of management (16). The recovery of applied nitrogen also followed the law of diminishing returns. Nitrogen recovery at highest level of nitrogen application (360 N) was distinctly lower than at 40 N and 120 N levels. Smaller quantities are thus utilized more efficiently. Among the grasses Brachiaria showed the highest recovery of nitrogen, while Napier was the lowest in this respect with only 43 per cent. recovery at 40 N level. Since Brachiaria shows most rapid regrowth, while Napier is the slowest to recover from defoliations, it would appear that there is a positive correlation between rapidity of growth and the efficiency of nitrogen recovery. With slower growing tussock-type grasses weed infestation is also considerably higher, and the resulting competition results in further depression of nitrogen recovery in the grass herbage.

Nitrogen utilization efficiency, as distinct from efficiency of nitrogen recovery, was highest in Guinea, notwithstanding the fact that Brachiaria produced the highest yields of dry matter. The high efficiency of nitrogen utilization in Guinea may possibly be due to the shallow root system concentrated just below ground level, which could have promoted efficient absorption of the applied nitrogen. The high nitrogen requirement of grasses, the extent of depletion of soil nitrogen, and the maintenance of a low ratio of digestible protein to starch equivalent are the factors which elucidate the need of nitrogenous fertilizers in pastures.

Some of the adverse effects of heavy applications of nitrogen must also be considered in this discussion. Although the quantity and quality of forage varied in direct proportion to the amount of nitrogen applied, it must also be remembered that there are some hazardous effects linked with this high productivity. The lowering of pH, rapid exhaustion of the other important nutrients in the soil and nitrate toxicity in the forage are some of the main hazards. The reduction in pH limits the availability of phosphates, calcium, sulphur and potassium (10). The activities of the soil microbes are also reported to be reduced by the reduction in pH (10). In this experiment there was a fall by one unit in pH from the lowest to the highest level of the applied nitrogen.

The nitrate's toxicity in forage, associated with heavy application of nitrogen, has been treated lightly by many research workers. The accumulation of nitrates in forage is hazardous in two ways. Nitrates present in forage produce oxides of nitrogen when ensiled. These gases are poisonous to animals and human beings. Nitrates in forage when fed to ruminants can even cause death if the concentration exceeds certain limits (7). Ap. Griffith (11) gives the lower limit of nitrate nitrogen toxicity in herbage as 0.15 per cent. Brokington (4) in his trial with Rhodes Grass has shown that at the 378 N per acre level, this toxic limit of nitrate nitrogen is reached. It might be necessary to restrict the application of liberal doses of nitrogen because of this factor.

CONCLUSION

Among the grasses studied, Brachiaria gave the highest yield. The highest yield was at 30 days frequency of defoliation. Increase in the interval between defoliations resulted in a decrease in the quality of the herbage. Napier and Guinea are closely similar in regard to dry matter yields and quality of the forage. These two grasses produce highest dry matter yield under a cutting frequency of 90 days. Quantity and quality in these two grasses are negatively correlated. A compromise between the quantity and quality of the herbage is achieved with a 60 days interval between defoliations. Among the different nitrogen levels used, 120 pounds of nitrogen per acre was most satisfactory. The percentage recovery of the applied nitrogen was highest at this level of nitrogen application. Increasing levels of nitrogen also increased the quality of the herbage produced. There was a fall in the yield of grasses in the second year, and this fall was coincident with the fall in the soil nitrogen. The ratio of digestible crude protein to starch equivalent was higher, (*a*) at lower levels of nitrogen application, and (*b*) under less frequent defoliation. Brachiaria, due to its aggressive nature of growth and rapid recovery, thus excels the other two grasses in the feeding value of herbage.

SUMMARY

The promising potentialities of tropical grasses are adequately bestowed in Brachiaria, Guinea, Napier and these have been reviewed from time to time by research workers. Information in relation to this aspect of study is wanting in Ceylon. Among the grasses, Brachiaria ranked highest in quantity and quality. The difference observed in Napier and Guinea was not significantly large. In Napier and Guinea the quantity and quality were negatively correlated. Brachiaria gave the highest yield coupled with the quality at 30 days of defoliation. There was a decrease in yield of grasses in the second year, and it is attributed to the decrease in the soil nitrogen from the first to the second year. The yields of grasses were progressive with the amounts of nitrogen applied. Concomitant with the dry matter yield, the nitrogen fertilizer also increased the chemical quality and the nutritive value of the grasses. The efficiency of nitrogen utilization decreased with the increase in levels of applied nitrogen, and so did its recovery. Possible assumptions and tentative suggestions have been discussed at length.

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TABLE 1.—Two way tables giving the average Dry Matter Yield per acre, for Grasses at different Frequencies of Defoliation, and at different Nitrogen Levels, and their respective interactions

(Figures are all in thousand pounds of Dry Matter)

I.—GRASSES X CUTTINGS

Cutting intervals :	30 days	60 days	90 days	Average
1st Year	13.00	19.42	20.58	17.67
Napier				
2nd Year	6.75	11.67	20.50	12.97
1st Year	13.92	16.25	18.83	16.33
Guinea				
2nd Year	9.25	13.33	18.08	13.56
1st Year	25.75	22.67	21.83	23.42
Brachiaria				
2nd Year	16.42	16.75	17.83	17.00
1st Year	17.56	19.44	20.42	
Average				
2nd Year	10.75	13.65	19.06	

II.—GRASSES X NITROGEN

Nitrogen Levels :	O N	40 N	12°N	36°N	Average
1st Year	12.78	14.00	17.56	26.33	17.67
Napier					
2nd Year	8.56	9.11	14.33	19.89	12.97
1st Year	11.44	13.11	16.78	24.00	16.33
Guinea					
2nd Year	7.11	9.44	14.45	23.22	13.56
1st Year	19.33	21.89	25.44	27.00	23.42
Brachiaria					
2nd Year	11.33	12.80	17.33	26.54	17.00
1st Year	14.52	16.33	19.93	25.78	
Average					
2nd Year	9.00	10.45	15.37	23.21	

L. S. D.— 0. 05	*1st Year*	*2nd Year*
1. Grasses	2.24	1.34
2. Cuttings	1.18	0.95
3. Nitrogen levels	1.14	1.00
4. Grasses X Cuttings	2.03	1.16
5. Grasses X Nitrogen	2.00	1.74
6. Cuttings X Nitrogen	—	1.17
Coefficient of Variation	11	13

III.—CUTTINGS X NITROGEN

Cuttings intervals / Nitrogen levels :—		ON	4ON	12ON	36ON	Average
30 days	1st Year	13.56	15.56	17.56	23.56	17.56
	2nd Year	7.51	8.64	10.48	16.37	10.75
60 days	1st Year	15.11	16.33	20.44	25.89	19.44
	2nd Year	8.60	9.41	14.89	21.70	13.65
90 Days	1st Year	14.89	17.11	21.78	27.89	20.42
	2nd Year	10.91	13.33	20.44	31.59	19.06
Average	1st Year	14.52	16.33	19.93	25.78	
	2nd Year	9.00	10.45	15.37	23.21	

TABLE IA.—Analysis of Variance

Treatments	*Calculated F Values* *1st Year*	*2nd Year*
1. Grasses	43.41**	21.88**
2. Cuttings	14.79**	83.57**
3. Nitrogen	152.71**	227. 4**
4. Grasses X Cuttings	23.41**	29.00**
5. Grasses X Nitrogen	6.83**	3.26*
6. Cuttings X Nitrogen	1.49	19.28**
7. Grasses X Cuttings X Nitrogen	1.43	0.83

TABLE 2.—Average Dry Matter Yield and Average Chemical Composition of Nutrients for the first and second years of study

GRASS.—PENNISETUM PURPUREUM—NAPIER

		First Year					*Second Year*				
Days	*N. Treat*	*D.M.Y.*	*C.P.%*	*C.F.%*	*E.E.%*	*Ash.%*	*D.M.Y.*	*C.P.%*	*C.F.%*	*E.E.%*	*Ash.%*
	ON	9,237	7.32	31.41	1.73	13.62	5,001	7.25	27.25	1.90	17.23
	4ON	10,514	8.09	30.86	1.95	13.81	4,691	8.48	29.15	1.93	17.34
30	12ON	12,260	8.41	29.76	2.05	14.19	6,196	8.76	29.16	2.01	17.87
	36ON	19,516	9.40	29.14	2.15	14.62	10,443	9.87	29.50	2.14	17.42
	ON	13,890	5.97	32.22	1.33	12.71	6,906	5.92	32.76	2.12	15.61
	4ON	14,972	6.63	31.42	1.76	13.28	7,228	6.38	31.10	2.47	16.23
60	12ON	19,767	6.76	29.92	2.09	14.17	13,827	7.35	30.67	2.01	16.37
	36ON	29,798	7.30	29.26	2.17	14.28	18,764	7.68	29.95	2.21	16.54
	ON	15,501	4.38	34.51	1.41	11.76	13,295	4.87	34.12	1.33	14.62
	4ON	16,468	4.47	34.38	1.46	12.02	15,030	5.30	33.85	1.58	14.53
90	2ON	20,545	4.75	31.52	1.60	12.13	23,122	5.61	33.20	1.55	14.20
	36ON	29,729	5.39	30.96	2.22	12.39	30,776	5.99	32.84	1.83	14.27

GRASS—PANICUM MAXIMUM—GUINEA

Days	*N. Treat*	*D.M.Y.*	*C.P.%*	*C.F.%*	*E.E.%*	*Ash.%*	*D.M.Y.*	*C.P.%*	*C.F.%*	*E.E.%*	*Ash.%*
	ON	10,212	7.30	32.51	1.67	11.33	5,431	8.44	29.79	1.87	14.36
	4ON	11,140	8.37	32.18	1.89	11.84	6,478	8.80	29.59	1.92	15.52
30	12ON	13,526	9.17	29.71	2.02	12.54	9.061	9.06	28.77	2.10	15.55
	36ON	20,584	10.50	28.93	2.15	13.59	15,477	9.81	28.44	2.26	16.33
	ON	11,925	5.55	29.79	1.28	11.06	7,181	6.71	34.48	1.61	13.93
	4ON	14,017	6.46	29.61	1.58	11.87	9,495	7.11	34.27	1.75	14.37
60	12ON	16,794	7.37	29.47	2.03	12.56	14,493	7.49	33.57	1.88	14.61
	36ON	21,973	7.09	28.54	2.13	13.37	22,007	9.91	33.28	2.09	14.67
	ON	12,046	3.75	31.77	1.25	9.28	9,005	4.26	31.77	1.43	11.65
	4ON	14,499	4.42	31.50	1.43	9.01	11,619	4.73	31.50	1.64	11.81
90	12ON	20,203	4.43	31.41	1.61	10.35	19,534	5.38	31.41	1.87	12.28
	36ON	29,145	4.93	30.14	2.05	11.49	32,085	5.95	30.14	2.19	12.31

GRASS—BRACHIARIA BRIZANTHA—BRACHIARIA

Days	*N. Treat*	*D.M.Y.*	*C.P.%*	*C.F.%*	*E.E.%*	*Ash.%*	*D.M.Y.*	*C.P.%*	*C.F.%*	*E.E.%*	*Ash.%*
	ON	21,087	6.23	32.99	1.87	9.34	11,496	7.14	30.55	1.84	12.11
	4ON	24,991	6.82	32.00	1.90	9.55	13,795	7.11	29.75	1.98	11.68
30	12ON	26,912	7.86	29.96	2.18	9.84	17,021	8.14	27.65	1.95	11.18
	36ON	29,970	9.12	27.37	2.21	10.85	23,308	9.10	23.20	1.92	1 .64
	ON	19,702	4.74	33.69	1.80	8.32	11,898	5.39	30.27	1.84	11.32
	4ON	20,477	5.96	33.48	1.89	9.14	12,860	5.47	30.63	1.91	11.31
60	12ON	24,494	6.01	33.36	1.92	9.50	17,395	6.26	30.27	2.03	12.22
	36ON	25,837	8.06	30.15	2.21	9.65	25,151	7.82	31.45	2.07	12.24
	ON	17,452	4.46	33.58	1.09	7.31	10,656	4.50	31.49	1.48	9.54
	4ON	20,458	4.80	32.48	1.29	7.67	12,230	4.91	29.99	1.51	9.91
90	12ON	24,741	5.37	31.83	1.32	8.97	17,277	5.21	30.19	1.85	9.62
	36ON	25,178	6.20	23.71	1.68	10.37	30,817	5.66	30.69	1.87	10.46

TABLE 3.—Average Digestible Nutrients

GRASS—PENNISETUM PURPUREUM—NAPIER

Days	N. levels	1st Year D.C.P.%	1st Year S.E.%	1st Year T.D.N%	2nd Year D.C.P.%	2nd Year S.E.%	2nd Year T.D.N%
30	ON	3.13	39.97	60.34	3.07	42.90	62.40
	40N	3.81	40.88	61.14	4.17	43.74	63.64
	120N	4.11	42.72	62.74	4.44	43.71	63.61
	360N	5.05	43.75	63.65	5.51	43.15	63.13
60	ON	2.02	38.63	59.16	1.98	37.73	58.38
	40N	2.55	39.97	60.34	2.34	40.48	60.79
	120N	2.66	42.28	62.23	3.16	41.20	61.41
	360N	3.11	43.56	63.38	3.44	42.40	62.46
90	ON	0.89	34.80	55.82	1.21	35.45	56.39
	40N	0.95	35.02	56.01	1.52	35.91	66.79
	120N	1.13	39.79	60.18	1.75	36.99	56.73
	360N	1.58	40.70	60.98	2.04	37.60	58.27

GRASS—PANICUM MAXIMUM—GUINEA

Days	N. levels	1st Year D.C.P.%	1st Year S.E.%	1st Year T.D.N%	2nd Year D.C.P.%	2nd Year S.E.%	2nd Year T.D.N%
30	ON	3.11	38.14	58.74	4.14	42.52	62.70
	40N	4.07	38.69	59.22	4.47	43.01	63.00
	120N	4.38	42.81	62.83	4.72	44.37	64.13
	360N	6.15	44.10	63.98	5.45	44.92	64.68
60	ON	1.70	42.52	62.70	2.61	34.84	55.85
	40N	2.41	42.90	62.90	2.91	35.22	56.18
	120N	2.93	43.19	63.16	3.28	36.37	57.19
	360N	3.17	44.76	64.52	4.56	37.12	57.61
90	ON	0.50	39.38	59.82	0.79	39.38	59.82
	40N	0.91	39.81	60.20	1.12	39.81	60.20
	120N	0.92	39.97	60.34	1.57	39.99	60.34
	360N	1.26	42.09	62.45	2.00	42.09	62.45

GRASS—BRACHIARIA BRIZANTHA—BRACHIARIA

Days	N. levels	1st Year D.C.P.%	1st Year S.E.%	1st Year T.D.N%	2nd Year D.C.P.%	2nd Year S.E.%	2nd Year T.D.N%
30	ON	2.22	42.03	62.14	2.98	41.44	61.63
	40N	2.71	42.38	62.40	2.91	41.58	62.75
	120N	3.61	42.98	62.45	3.66	46.22	65.81
	360N	4.78	46.15	66.22	4.76	53.64	72.30
60	ON	1.12	36.17	57.02	1.58	41.88	62.01
	40N	2.01	36.52	57.33	1.64	41.27	61.47
	120N	2.05	36.72	57.50	2.25	41.88	62.01
	360N	3.79	42.07	62.18	3.57	40.99	61.29
90	ON	0.94	36.25	57.09	0.97	39.84	60.23
	40N	1.17	36.49	57.78	1.24	40.33	60.42
	120N	1.56	38.28	59.74	1.45	41.33	61.42
	360N	2.20	42.80	61.56	1.78	41.17	61.39

TABLE 4.—Amount of Soil Nitrogen removed by Grasses at Zero Nitrogen levels at different Frequencies of Defoliation

(Expressed in pounds per acre)

Grasses	*Frequency of cuttings*	*Amount of Nitrogen removed* 1st year	2nd year	% decrease
Napier	30 days	108·1	58·06	46·3
	60 Days	135·8	65·36	51·2
	90 Days	108·8	104·1	4·3
Guinea	30 Days	119·2	73·45	61·6
	60 Days	105·9	76·35	26·9
	90 Days	72·28	64·88	10·23
Brachiaria	30 Days	210·4	119·2	43·3
	60 Days	150·9	85·45	43·2
	90 Days	123·9	76·4	38·6

TABLE 5.—Table giving in pounds the Total Starch Equivalent, Total Digestible Proteins and the Ratio of Total Digestible Protein to Total Starch Equivalent obtained in Three Grasses at Three Cuttings Frequencies and at Four Nitrogen Levels

		First Year								
Grasses :		*Napier*			*Guinea*			*Brachiaria*		
Days	*N. treats*	*TSE*	*TDP*	*RATIO*	*TSE*	*TDP*	*RATIO*	*TSE*	*TDP*	*RATIO*
	ON	3680	291	1 : 13	3876	320	1 : 12	8862	473	1 : 19
	40N	4305	400	1 : 11	4329	417	1 : 10	10750	682	1 : 16
30	120N	5289	505	1 : 10	5805	657	1 : 9	11298	973	1 : 12
	360N	8580	991	1 : 9	9064	1285	1 : 7	13800	1421	1 : 10
	ON	5421	282	1 : 19	5117	205	1 : 25	7092	224	1 : 32
	40N	6800	378	1 : 18	6020	335	1 : 18	7585	415	1 : 18
60	120N	8514	621	1 : 14	7224	449	1 : 16	9065	500	1 : 18
	360N	13112	935	1 : 14	9902	696	1 : 14	10836	979	1 : 11
	ON	5425	136	1 : 40	4680	59	1 : 79	6300	163	1 : 39
	40N	5775	155	1 : 37	5800	135	1 : 43	7790	236	1 : 33
90	120N	8200	234	1 : 35	8080	188	1 : 43	9633	385	1 : 25
	360N	12177	424	1 : 29	12222	368	1 : 33	10846	562	1 : 19
		Second Year								
	ON	2200	153	1 : 15	2339	225	1 : 10	4305	315	1 : 14
	40N	2068	193	1 : 11	2795	291	1 : 10	5376	373	1 : 14
30	120N	2768	277	1 : 10	4004	427	1 : 9	7360	613	1 : 2
	360N	4472	577	1 : 8	3975	750	1 : 5	12042	1056	1 :1
	ON	2622	135	1 : 20	2520	188	1 : 13	4158	154	1 : 27
	40N	2880	171	1 : 17	3325	277	1 : 12	4469	178	1 : 25
60	120N	5658	436	1 : 13	5220	473	1 : 11	6468	347	1 : 19
	360N	7896	649	1 : 12	8140	851	1 : 9	9280	833	1 : 11
	ON	4655	162	1 : 29	3510	73	1 : 48	4494	101	1 : 45
	40N	5400	231	1 : 23	4640	132	1 : 35	5124	150	1 : 34
90	120N	8547	402	1 : 21	7800	305	1 : 26	7266	252	1 : 29
	360N	11704	630	1 : 19	13482	649	1 : 21	12628	558	1 : 23

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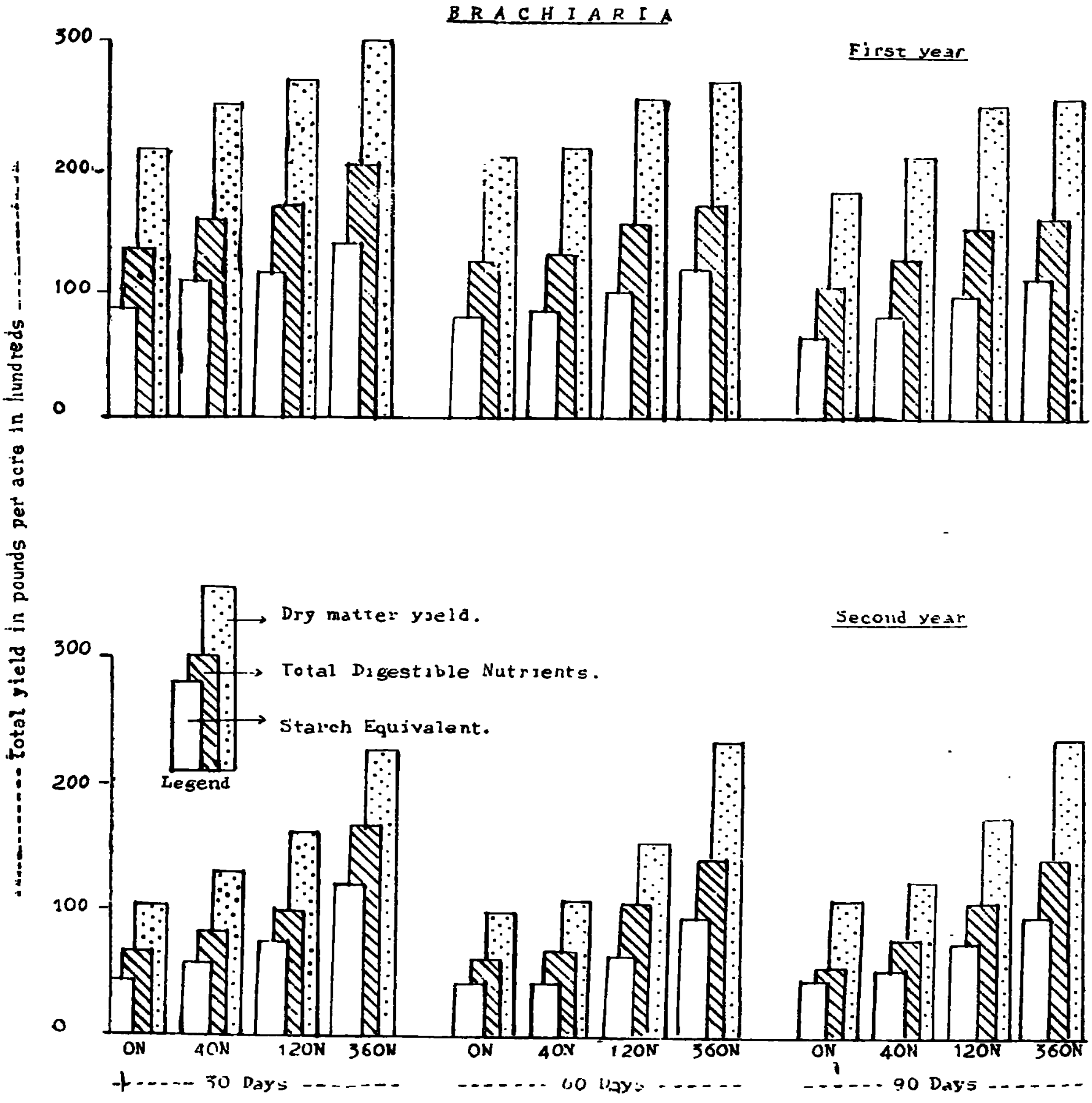
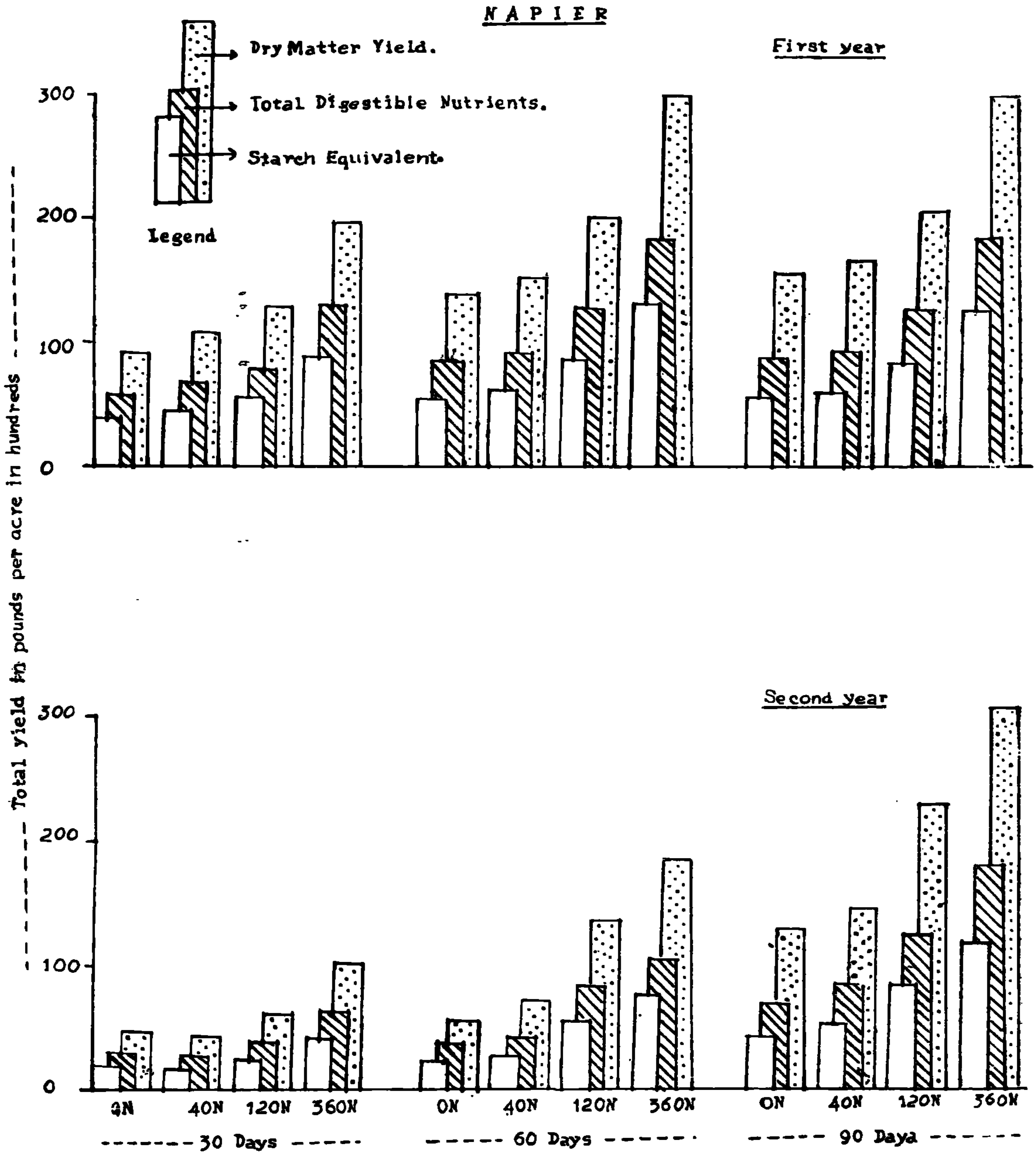
GRAPH 1 A.—Dry matter Yield, Digestible Nutrients and Starch Equivalent in pounds per acre for a whole year's herbage production, under different frequencies of defoliation and different Nitrogen Levels



GRAPH 1 B.—Dry Matter Yield, Total Digestible Nutrients and Starch Equivalent in pounds per acre for a whole year's herbage production, under different frequencies of defoliation and different Nitrogen Levels



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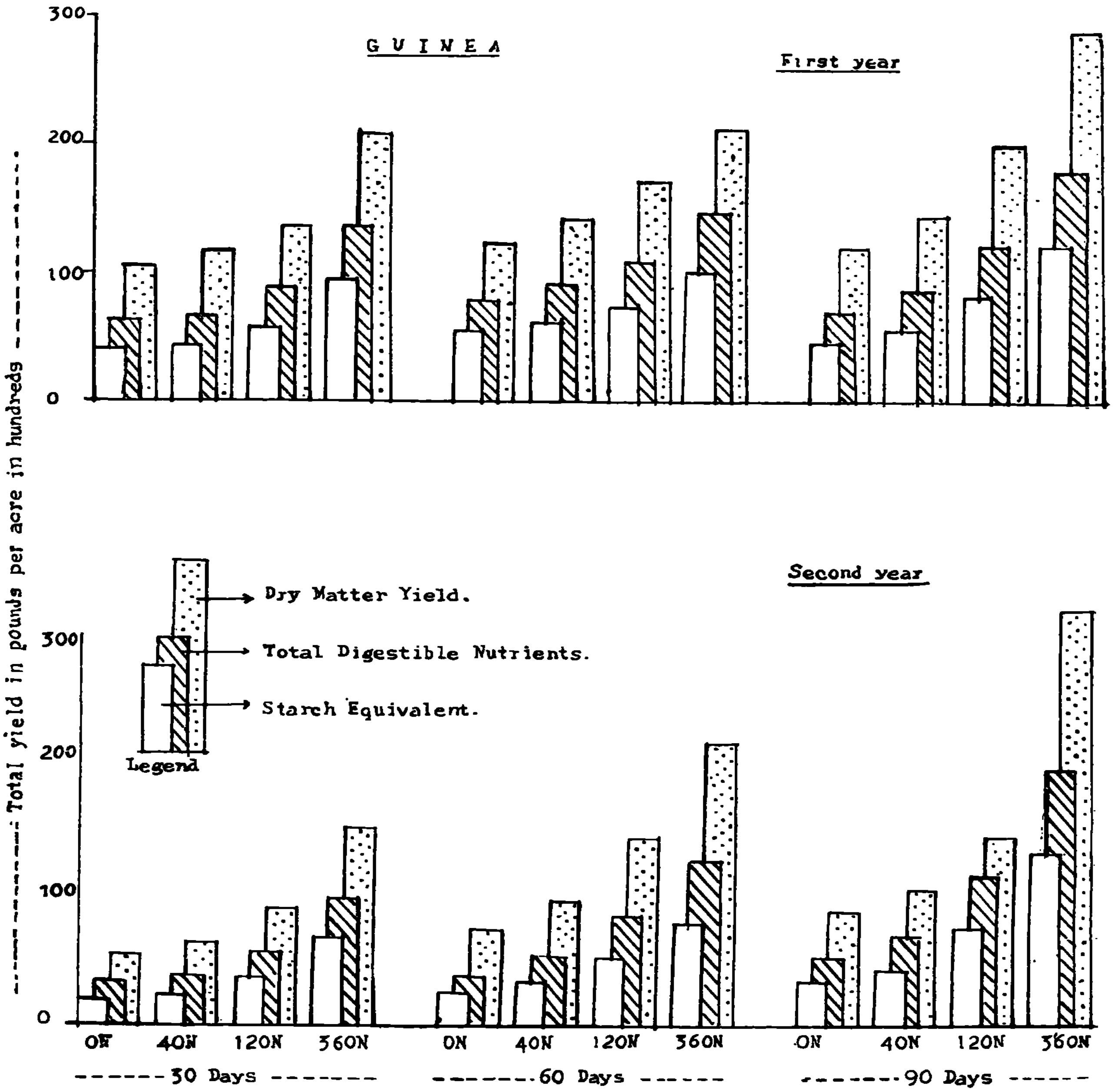
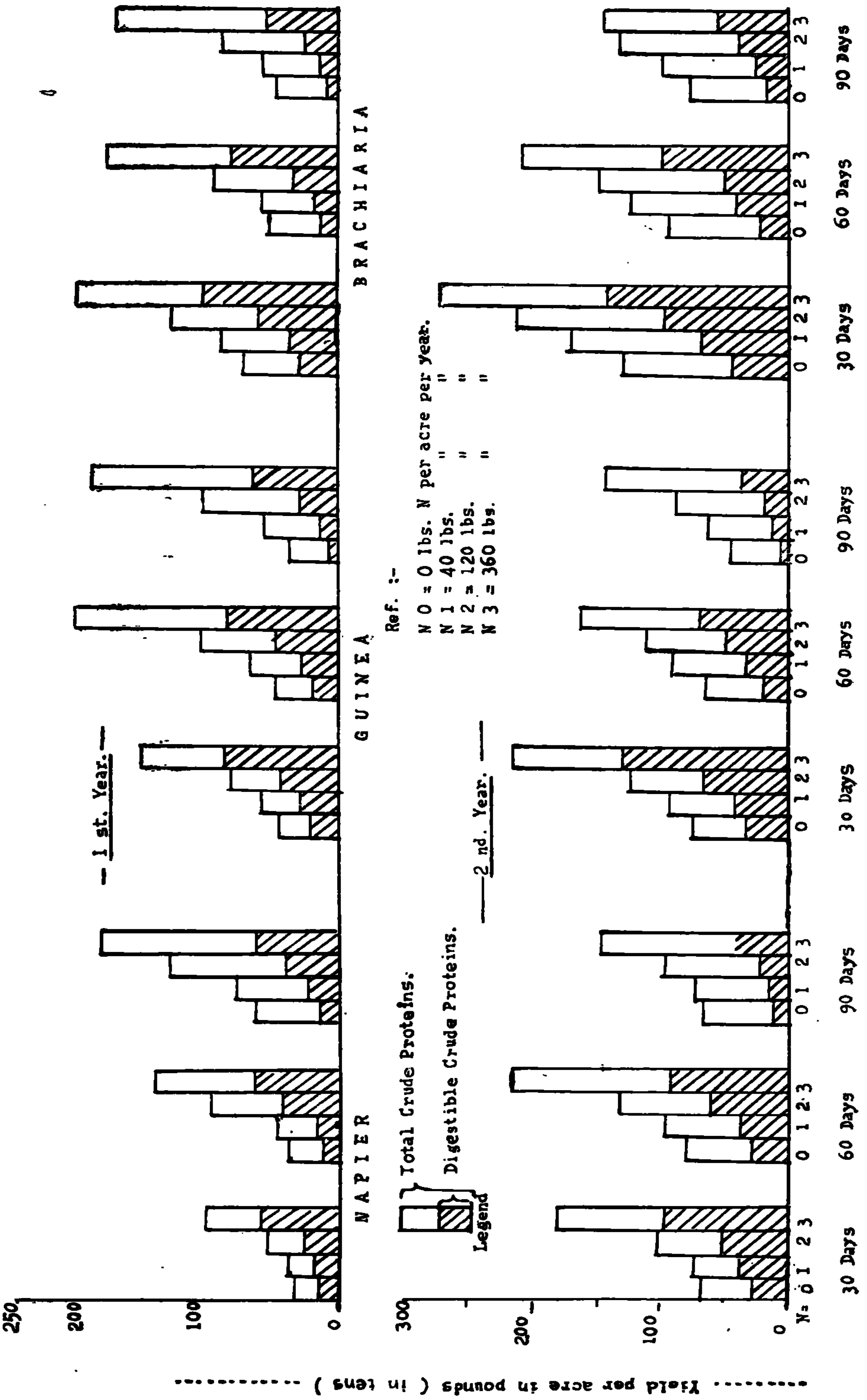
GRAPH 1 C.—Dry Matter Yield, Total Digestible Nutrients and Starch Equivalent in pounds per acre for a whole year's herbage production, under different frequencies of defoliation and different Nitrogen Levels



GRAPH 2.—Total Crude Proteins and the Digestible Fraction for different Grasses at different Frequencies of Defoliation and at different Nitrogen Levels



GRAPH 3.—Percentage of Starch Equivalent for different grasses at different cutting Frequencies and at different Nitrogen Levels