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Effects of Nitrogen Fertilization and Frequency of Cutting on the Yield and Composition of Napier Grass in Puerto Rico[1]

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INTRODUCTION

Napier or elephant grass (*Pennisetum purpureum* Schum.) (fig. 1) is probably the highest yielding and one of the most widely used tropical grasses. Dairy cows in Puerto Rico are fed almost exclusively on cut Napier grass supplemented with concentrates. This grass is often grown on very expensive land near the large urban areas where most of the dairies are located. In densely populated Puerto Rico, with about 650 persons per square mile, many are forced to keep the family cow on a small patch of land near the house. In both cases it is essential to obtain maximum yields of forage per unit area.

There is very little information on the response of Napier grass to nitrogen fertilization. Studies have generally been limited to the effects of manuring or of very light applications of nitrogen on the productivity of this grass. In Puerto Rico, Rodríguez (*4*),[3] found that applications of 200 pounds of nitrogen per acre yearly more than doubled yields of Napier grass, while Vicente, *et al.* (*5*), suggested that the application of 400 or more pounds of nitrogen per acre yearly to Napier may be warranted.

The effect of frequency of cutting on the yield and composition of Napier grass, however, has received considerable attention. Wilsie (*7*), in Hawaii, found that yields increased, but protein, phosphorus, and calcium content decreased progressively as harvest interval was lengthened from 6 to 14 weeks. Watkins and Lewy (*6*), in San Salvador, and Patterson (*2*), in Trinidad, obtained similar results and the latter also reported that the crude-fiber content of the forage increased with length of harvest interval.

[1] This work was carried out cooperatively between the U. S. Department of Agriculture and the Agricultural Experiment Station of the University of Puerto Rico.

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[3] Italic numbers in parentheses refer to Literature Cited, p. 227.

Rivera-Brenes (*3*) in Puerto Rico, however, reported that higher yields were obtained when Napier grass was cut at 40- rather than 90-day intervals, and that the lignin content of the forage increased and protein, ash, and carotene content decreased with length of the harvest interval.

This paper presents the results of an experiment carried out to characterize the response of Napier grass to nitrogen fertilization as affected by

FIG. 1.—Sixty-day-old Napier grass ready for cutting. When this grass was properly fertilized about 130 tons of green forage, or 44,561 pounds of dry matter, having a crude-protein content of 9.7 percent, were produced per acre yearly.

frequency of cutting and season of the year. The effects of treatments on forage composition and on soil acidity were also studied.

MATERIALS AND METHODS

The experiment was carried out at Río Piedras over three consecutive years. The mean annual temperature is about 76° F. with seasonal variations of less than 10° F. Annual rainfall was 62.8, 93.4, and 57.4 inches for the first, second, and third years of experimentation, respectively.

The soil is a Toa clay loam, which is a deep, well-drained, alluvial soil. Initially, the surface 6 inches averaged 2.9 percent of organic matter, 0.15 percent of nitrogen, 20.3 m.e. exchange capacity, and 16.5 m.e. of exchangeable bases per 100 gm. of soil, and had a pH of 5.1.

The treatments used were as follows:

Harvest intervals (Days)	*Nitrogen levels (Pounds N per acre yearly)*
40	0
	200
60	400
	800
90	1,200
	2,000

All combinations of these treatments were tested using a split-plot design with harvest intervals as the main plots and nitrogen levels as the subplots. All treatments were replicated four times. Subplots were 15 x 18 feet, surrounded by ditches to prevent fertilizer from washing into adjoining plots.

The upper 6 inches of soil in all plots was limed to a pH of about 7 at the start of the experiment. Blanket additions of phosphorus and potassium were made at a rate of 300 pounds P_2O_5 from 20-percent superphosphate per acre in one annual application, and 600 pounds K_2O from KCl per acre annually, in four to nine equal applications, depending on frequency of cutting. The nitrogen was applied as ammonium sulfate in four to nine equal applications yearly, depending on frequency of cutting.

The grass was cut at the prescribed intervals, weighed, and the forage removed from the plots. Samples from each plot at every harvest were analyzed for dry matter and total nitrogen. The crude-protein content was calculated using the factor 6.25 times N. Samples were composited by plots at the end of the first year and analyzed for calcium, phosphorus, potassium, magnesium, and lignin. During the third year, yields only were determined. Yields were taken over two 60-day periods after terminating the experiment to determine the residual effects of the treatments.

At the end of the experiment the soil in all plots cut every 60 days and receiving 0, 800, and 1,200 pounds of nitrogen per acre yearly was sampled at 6-inch intervals to a depth of 4 feet and the pH and exchangeable bases determined.

RESULTS

EFFECT OF LENGTH OF HARVEST INTERVAL

The data in table 1 and figure 2 show that yields increased greatly with length of harvest interval. At the 800-pound level of nitrogen, Napier grass produced 24,520, 44,561, and 75,661 pounds of dry matter per acre yearly, when cut at 40-, 60-, and 90-day intervals, respectively. The dry-matter content of the forage also increased with the harvest interval, averaging 14.1, 17.1, and 25.1 percent, respectively, for these intervals.

The protein content of the forage, however, decreased markedly with length of harvest interval, averaging at the 800-pound level of nitrogen, 12.9, 9.7, and 6.9 percent when the grass was cut at 40-, 60-, and 90-day intervals, respectively.

TABLE 1.—*The effects of nitrogen fertilization and frequency of cutting on the yield and protein content of Napier grass and on the efficiency of utilization of the applied nitrogen, over a 2-year period*

Nitrogen applied per acre yearly	Yield of green forage per acre yearly	Yield of dry matter per acre yearly	Crude-protein content	Crude-protein yield per acre yearly	Recovery of N in forage	Dry matter produced per pound of each increment of N
			Grass cut every 40 days			
Lb.	*Lb.*	*Lb.*	*Percent*	*Lb.*	*Percent*	*Lb.*
0	65,799	9,586	8.3	798	—	—
200	105,701	15,213	8.9	1,353	44.5	28.1
400	140,498	20,300	9.9	2,003	48.2	25.4
800	173,996	24,520	12.9	3,177	48.4	10.5
1,200	225,698	31,606	14.9	4,711	52.2	17.7
2,000	201,712	26,943	17.6	4,753	31.6	—
			Grass cut every 60 days			
0	92,343	15,150	6.5	983	—	—
200	148,754	24,617	7.2	1,780	63.8	47.3
400	214,993	36,727	7.9	2,892	76.4	60.6
800	259,911	44,561	9.7	4,329	66.9	19.6
1,200	273,282	46,578	11.9	5,556	61.0	5.0
2,000	276,025	46,616	13.8	6,437	43.6	—
			Grass cut every 90 days			
0	136,301	30,431	5.4	1,649	—	—
200	182,530	42,710	4.9	2,092	35.4	61.4
400	230,376	56,517	5.4	3,054	56.2	69.0
800	300,900	75,661	6.9	5,218	71.4	47.9
1,200	288,183	69,531	8.2	5,673	53.7	—
2,000	316,229	76,659	9.6	7,377	45.8	.8

Protein yields increased with length of harvest interval, averaging at the 800-pound level of nitrogen, 3,177, 4,329, and 5,218 pounds per acre yearly when the grass was cut at 40-, 60-, and 90-day intervals, respectively.

Generally, more of the applied nitrogen was recovered when the grass was cut every 60 days, while the dry matter produced per pound of fertilizer nitrogen tended to increase with length of harvest interval.

The lignin content of the forage increased with length of harvest interval, averaging 7.17, 8.72, and 10.78 percent when the grass was cut every 40, 60, and 90 days, respectively.

The data in table 2 show that the phosphorus and potassium contents of the forage decreased sharply with length of the harvest interval, while the calcium and magnesium contents showed a similar tendency. The phosphorus content of the forage averaged 0.46, 0.35, and 0.26 percent, the calcium content 0.36, 0.29, and 0.27 percent, the magnesium content 0.28, 0.21, and 0.19 percent, and the potassium content 2.73, 1.94, and 1.26 percent with a 40-, 60-, and 90-day harvest interval, respectively.

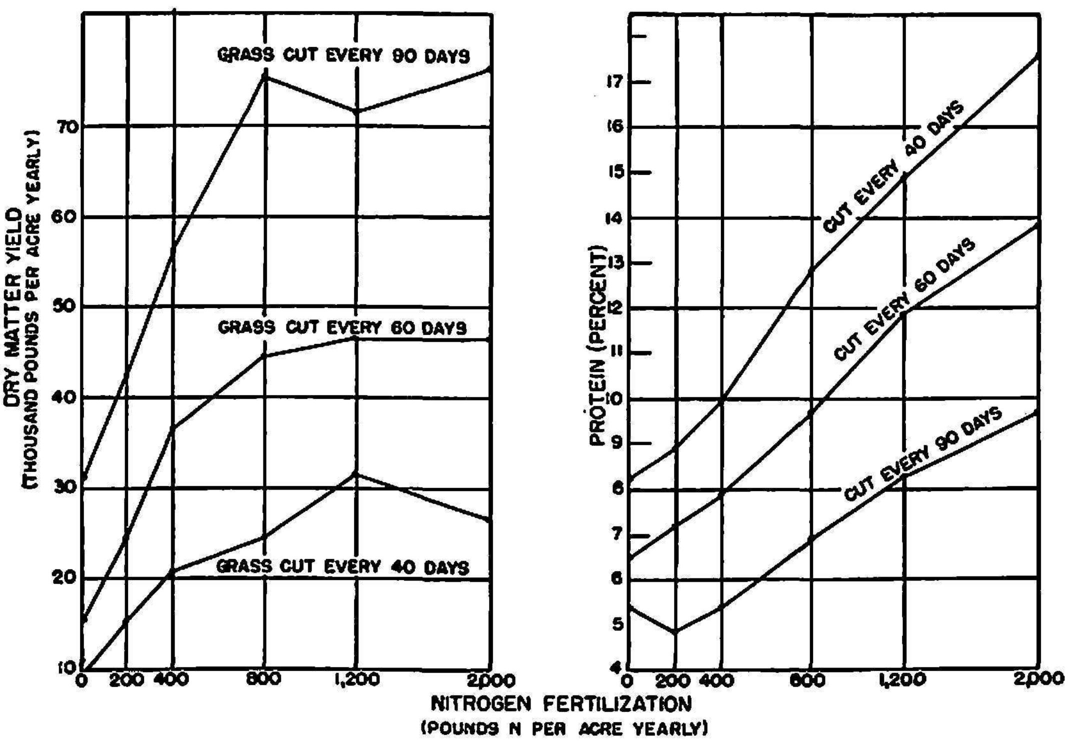

FIG. 2.—Effects of nitrogen fertilization and frequency of cutting on yield and protein content of Napier grass.

Less weeding was required with the longer harvest intervals. Plots receiving 800 pounds of nitrogen per acre yearly had to be weeded 1, 3, and 6 times a year when cut at 90-, 60-, and 40-day intervals, respectively.

EFFECT OF NITROGEN FERTILIZATION

The data in table 1 and figure 2 show that yields increased rapidly with nitrogen fertilization up to the 800-pound level at all harvest intervals. With a 60-day interval, yields were about tripled to 44,561 pounds of dry matter, or about 130 tons, of green forage per acre yearly by the application of 800 pounds of nitrogen. Detailed analysis of the data shows that a strong response in yield up to this level of nitrogen occurred at all seasons of the year.

The protein content of the forage increased with nitrogen fertilization

TABLE 2.—*The effects of nitrogen fertilization and harvest interval on the mineral and lignin content of Napier grass and on withdrawal of nutrients in forage*[1]

Nitrogen fertilization (pounds N per acre yearly)	Results at harvest intervals indicated							
	40 days		60 days		90 days		Average	
	Percentage composition[2]	Pounds withdrawn per acre yearly	Percentage composition[2]	Pounds withdrawn per acre yearly	Percentage composition[2]	Pounds withdrawn per acre yearly	Percentage composition[2]	Pounds withdrawn per acre yearly
	Nitrogen							
0	1.25	127.4	0.94	152.6	0.75	171.2	0.98	150.4
400	1.58	344.5	1.33	499.9	.88	417.7	1.28	420.7
800	1.98	503.5	1.52	674.3	1.02	688.1	1.51	622.0
Average	1.60	325.2	1.26	442.3	0.88	425.7		
	Phosphorus							
0	0.59	60.1	0.43	69.8	0.34	77.6	0.45	69.2
400	.48	104.6	.36	135.3	.26	123.4	.37	121.1
800	.32	81.4	.27	119.8	.19	128.2	.26	109.8
Average	0.46	82.1	0.35	108.3	0.26	109.7		
	Calcium							
0	0.38	38.7	0.32	52.0	0.29	66.2	0.33	52.3
400	.35	76.3	.28	105.2	.23	109.2	.29	96.9
800	.35	89.0	.27	119.8	.29	263.1	.30	157.3
Average	0.36	68.0	0.29	92.3	0.27	146.2		
	Potassium							
0	3.94	401.5	2.81	456.3	2.02	461.2	2.92	439.6
400	2.39	521.1	1.77	665.3	1.06	503.2	1.74	563.2
800	1.87	475.6	1.25	554.5	.70	472.2	1.27	500.8
Average	2.73	465.9	1.94	558.7	1.26	478.8		
	Magnesium							
0	0.18	18.3	0.18	29.2	0.17	38.8	0.18	28.8
400	.30	65.4	.19	71.4	.19	90.2	.23	75.7
800	.35	89.1	.27	119.8	.22	148.4	.28	119.1
Average	0.28	57.6	0.21	73.5	0.19	92.5		
	Lignin							
0	6.65	—	7.92	—	9.58	—	8.05	—
400	6.94	—	8.81	—	11.13	—	8.96	—
800	7.93	—	9.44	—	11.63	—	9.67	—
Average	7.17	—	8.72	—	10.78	—		

[1] All values are averages of 4 replicates composited from all cuttings over a full 1-year period.

[2] On dry-weight basis.

up to the highest level tested, averaging when cut every 60 days, 6.5, 7.9, 9.7, and 13.8 percent when fertilized with 0, 400, 800, and 2,000 pounds of nitrogen per acre yearly, respectively. The highest protein content of 17.6 percent was attained with a 40-day harvest interval and 2,000 pounds of nitrogen per acre yearly. The assumption is made that the nitrogen was essentially all in the amino form, since no more than traces of nitrates were found in the forage.

Protein yields increased rapidly with nitrogen fertilization up to the maximum level tested, averaging with a 60-day harvest interval, 983, 4,329, and 6,437 pounds per acre yearly, when fertilized with 0, 800, and 2,000 pounds of nitrogen per acre yearly, respectively.

The data in table 1 show that a high proportion of the fertilizer nitrogen was recovered in the forage. With a 60-day harvest interval, 76.4, 66.9, and 61.0 percent of the 400-, 800-, and 1,200-pound applications of nitrogen, respectively, was recovered in the forage. When residual yields are considered, recovery of fertilizer averages about 5-percent higher. Napier grass obtained about 150 pounds of nitrogen per acre yearly from the soil when no nitrogen was applied. The efficiency of utilization of applied nitrogen dropped rapidly beyond the 400-pound level. With a 60-day harvest interval, 47.3, 60.6, 19.6, and 5 pounds of dry matter were produced per pound of each successive increment of nitrogen.

The data in table 2 show that the phosphorus and potassium contents of the forage decreased significantly with increased nitrogen rates at all harvest intervals, but the calcium and magnesium contents were not greatly affected by nitrogen fertilization. With a 60-day harvest interval the phosphorus content of the forage was 0.43, 0.36, and 0.27 percent and the potassium content 2.81, 1.77, and 1.25 percent at the 0-, 400-, and 800-pound levels of nitrogen respectively.

The lignin content of the forage increased with nitrogen fertilization, averaging when cut every 60 days, 7.92, 8.81, and 9.44 percent at the 0-, 400-, and 800-pound levels of nitrogen, respectively.

Nitrogen fertilization reduced weed growth. Plots cut every 60 days and receiving no nitrogen had to be weeded after each harvest, while those receiving 800 pounds or more of nitrogen required only three light weedings a year.

NUTRIENT WITHDRAWAL AT HIGH YIELD LEVELS

Table 3 shows that intensively managed Napier grass withdraws very large amounts of nutrients and, therefore, heavy fertilization is required to sustain high yields. Withdrawal of nitrogen and potassium was particularly high with 674 and 554 pounds, respectively, withdrawn per acre yearly. Heavier applications of fertilizer than indicated are required to compensate for losses by leaching, fixation, etc.

Table 2 shows that nutrient withdrawal generally followed yields, increasing with nitrogen rates and length of harvest intervals. For example, withdrawal of calcium was more than tripled, that of phosphorus was about doubled and that of nitrogen was more than quintupled when the harvest interval was increased from 40 to 60 days and nitrogen rates from 0 to 800 pounds per acre yearly.

RESIDUAL EFFECTS ON YIELDS

Plots harvested at longer intervals during the course of the experiment produced higher residual yields. Plots harvested at 40-, 60-, and 90-day intervals during the course of the experiment yielded 2,921, 3,389, and 4,284 pounds of dry matter per acre, respectively, over a 60-day period ending 4 months after the experiment was terminated.

TABLE 3.—*Withdrawal of nutrients by intensively managed Napier grass producing 44,561 pounds of dry matter per acre yearly*

Nutrients	Pounds withdrawn per acre yearly	Equivalent to—
Nitrogen	674	3,300 lb. ammonium sulfate
Phosphorus	120	1,350 lb. 20-percent superphosphate
Potassium	554	1,100 lb. potassium chloride
Calcium	120	300 lb. limestone
Magnesium	120	600 lb. magnesium sulfate

Higher residual yields were produced by plots receiving heavy nitrogen applications during the course of the experiment. The following tabulation shows the effect of nitrogen rates used during the course of the experiment on yields and protein content of forage produced over a 60-day period, ending 6 months after the last application of nitrogen.

Nitrogen level	*Pounds dry matter per acre*	*Percent protein*
0	1,270	7.1
200	2,002	7.1
400	2,997	7.8
800	3,839	8.2
1,200	7,431	11.2
2,000	8,958	13.3

EFFECT OF SEASON OF THE YEAR

Figure 3 shows that season of the year had a strong effect on forage production with yields varying from the average by as much as 70 percent. January, February, and March yields were below average, while May, June, July, and August yields were above average during all three years.

Season of the year also had a marked effect on protein content of the forage which varied, with a 60-day harvest interval and 800-pound level of nitrogen, from as low as 7.4 to as high as 12.9 percent. In general, highest protein contents were found during seasons of slow growth, and vice versa.

High production was maintained throughout the 3-year course of the experiment provided the grass was properly managed. The yields of plots receiving no nitrogen, however, dropped off every year, as did those of the lightly fertilized plots cut every 40 days. The data in figure 3 show that, with proper management, yields during the driest year on record (1957) were only about 17 percent less than during the very wet year of 1956.

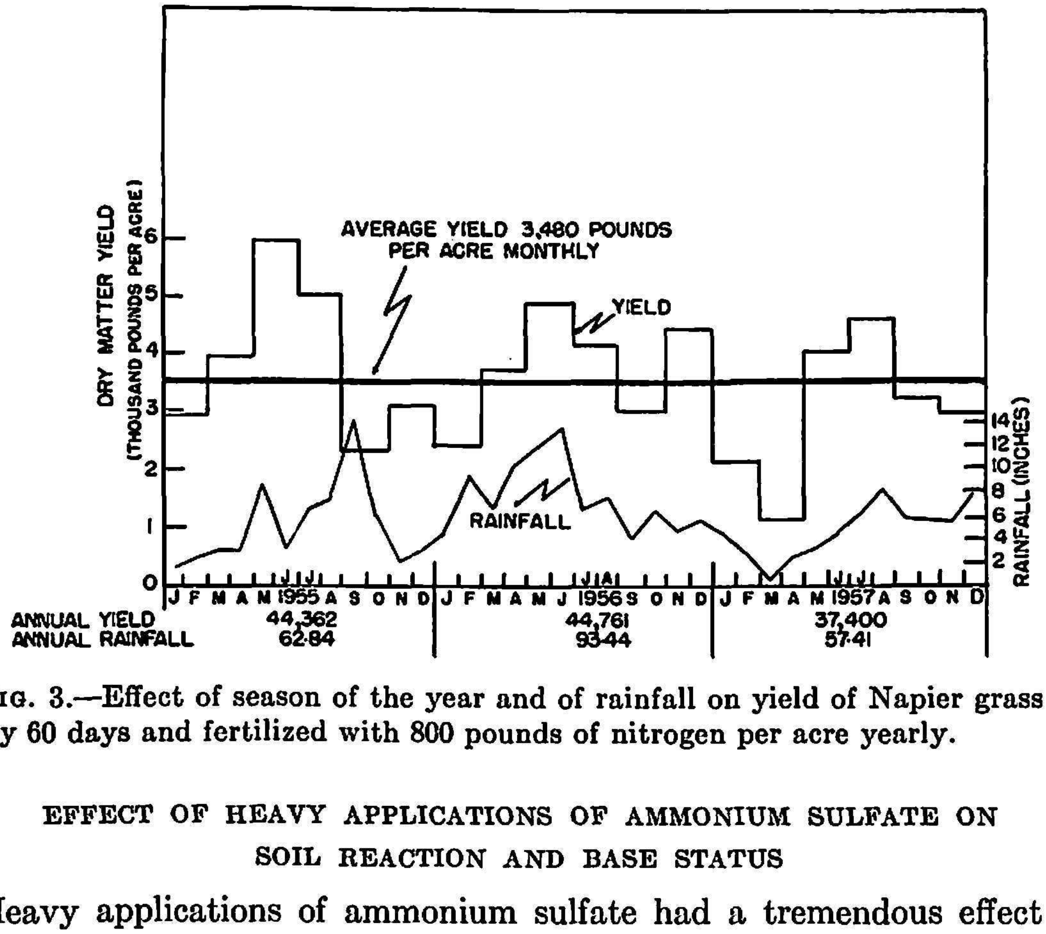

FIG. 3.—Effect of season of the year and of rainfall on yield of Napier grass cut every 60 days and fertilized with 800 pounds of nitrogen per acre yearly.

EFFECT OF HEAVY APPLICATIONS OF AMMONIUM SULFATE ON SOIL REACTION AND BASE STATUS

Heavy applications of ammonium sulfate had a tremendous effect on soil acidity and base status as shown by the data in table 4 and discussed in detail by Abruña, Pearson, and Elkins (*1*). The application of 800 pounds of nitrogen as ammonium sulfate per acre yearly for three consecutive years reduced the pH of the upper 6 inches of soil from 7.0 to 4.1, and the exchangeable base content from 21.9 to 11.5 m.e. per 100 gm. of soil. At the 1,200-pound level of nitrogen the pH was further reduced to 3.5 and the exchangeable bases to 4 m.e. per 100 gm. of soil. At this rate of nitrogen fertilization the base status of the soil was affected to a depth of 2 feet in the profile. There was no indication of an accumulation of bases in the lower horizons of soil.

DISCUSSION

Although highest yields were obtained when Napier grass was cut every 90 days, the forage was of poor quality as indicated by its low protein and mineral, and high lignin contents. With the 40-day harvest interval, on the other hand, quality of the forage was excellent but yields were relatively low, it was difficult to maintain a good stand, frequent weeding was necessary, and cost of harvesting was higher. A 60-day harvest interval would seem to be a reasonable compromise between high yields and ease of management on one hand and quality of forage on the other.

The application of up to 800 pounds of nitrogen per acre yearly appears economical under the conditions of this experiment. About 10 pounds of dry forage of fair quality is required to produce a 1-pound gain in weight—worth 16 cents—with young steers, and nitrogen is worth about 15 cents a pound in Puerto Rico. This is on the assumption that the break-even point is that at which each pound of nitrogen produced 15 pounds of dry forage. It appears from table 1 that applications of up to 800 pounds of nitrogen would be definitely profitable with a 60-day harvest interval. Similar calculations in terms of milk production would, of course, show a wider profit margin. Also, the cost of nitrogen could be greatly reduced by using anhydrous ammonia on mechanizable lands. Other important considerations are the increased protein content of the forage, the high proportion of fertilizer nitrogen recovered, and the reduced growth of weeds at this level of nitrogen.

TABLE 4.—*The effect of nitrogen fertilizer in the form of ammonium sulfate on the reaction and exchangeable-base status at different depths of a Toa clay loam planted to Napier grass, over a 3-year period*

Depth (inches)	pH for—			M.e. exchangeable bases per 100 gm. of soil for—		
	No N	800 lb. N per acre yearly	1,200 lb. N per acre yearly	No N	800 lb. N per acre yearly	1,200 lb. N per acre yearly
0-6	7.0	4.1	3.5	21.9	11.5	4.0
6-12	6.1	5.0	4.1	20.6	17.5	9.0
12-18	5.6	5.2	4.3	17.7	17.7	11.9
18-24	5.6	5.6	4.8	18.3	17.5	16.2
24-36	5.9	5.9	5.9	21.4	21.1	19.8
36-48	6.1	6.0	5.9	21.1	20.4	20.4

[1] All values are averages of 4 replications.

Thus, about a 60-day harvest interval and 800 pounds of nitrogen per acre yearly appear best for Napier grass under the conditions of this experiment. About 130 tons of green forage, or 44,561 pounds, of dry matter having a protein content of 9.7 percent were produced per acre yearly with this treatment. This is sufficient to meet the roughage requirements of more than 6 mature cows or steers.

Yields of this magnitude can be obtained with proper management under the widely different soil and climatic conditions found on the Island, provided moisture is adequate. In other experiments by the authors, Napier grass yielded 32,900 pounds of dry matter per acre yearly on a steep clay soil in the mountain region, and 51,491 pounds on a very fertile, irrigated soil on the semiarid south coast.

The increase in lignin content and decrease in protein content of the forage with length of harvest interval is a normal result of maturity. The decrease in mineral content may have been caused partly by the dilution effect of higher yields in the presence of a relatively constant amount of available minerals in the soil, as well as by maturity.

The increase in protein content with nitrogen fertilization is to be expected but the concurrent increase in lignin content is difficult to explain. The decrease in phosphorus and potassium contents with increased nitrogen fertilization is probably again a reflection of the dilution effect. The calcium and magnesium contents did not follow the same pattern, probably due to an abundance of these nutrients in the soil.

Several factors were apparently responsible for the variable productivity of Napier grass at different seasons of the year (fig. 3). Although rainfall was clearly an important factor, it does not explain all the differences. For example, during January, February, and March of 1956, with a total of 21.1 inches of rain, yields were no higher than during the same period of 1955, with only 7.4 inches of rain. Also, yields during the last 2 months of 1956 with 11 inches of rain were almost twice as high as during the first 2 months of 1956 with 14.5 inches of rain. Apparently, the shorter days and somewhat cooler weather at the beginning of the year contributed towards slowing the growth rate of Napier grass.

The data suggest that variations in forage production throughout the year could be kept within a range of about 30 percent of the average by using a longer harvest interval and heavier nitrogen fertilization during seasons of slow growth and a shorter harvest interval and lighter fertilization during seasons of fast growth.

The heavy losses of soil bases occurring with the application of 2 tons of ammonium sulfate (800 pounds of nitrogen) per acre yearly are equivalent to about 2½ tons of calcium carbonate per acre yearly. This loss may be reduced by using a source of nitrogen having a lower residual acidity. If residually acid sources are used, annual applications of limestone would help to prevent loss of bases deep in the profile.

SUMMARY

The effects of nitrogen rates ranging from 0 to 2,000 pounds of N per acre yearly and of 40-, 60-, and 90-day harvest intervals on the yield and composition of Napier grass and on soil acidity, were determined for three consecutive years.

Yields increased with nitrogen fertilization to at least the 800-pound level during all seasons. Crude-protein contents and protein yields increased with nitrogen fertilization up to the 2,000-pound level. More than 60 percent of the fertilizer nitrogen was recovered in the forage at all rates up to 1,200 pounds per acre yearly, but efficiency of utilization in terms of dry matter produced per pound of nitrogen decreased beyond the 400-pound level. The phosphorus and potassium contents of the forage decreased, but the lignin content increased with increasing nitrogen rates. The calcium and magnesium contents were not markedly affected by nitrogen fertilization.

Dry-matter and protein yields and lignin content of the forage increased, while the protein, phosphorus, calcium, magnesium, and potassium contents decreased with length of harvest interval.

With a 60-day harvest interval and 800 pounds of nitrogen per acre yearly, which seemed to be the optimum combination, Napier grass yielded 44,561 pounds of dry matter, or about 130 tons of green forage, per acre yearly, containing 9.7 percent of protein. With this treatment, Napier grass removed 674 pounds of nitrogen, 554 of potassium, and 120 each of calcium, magnesium, and phosphorus per acre yearly from the soil.

Over-all yields did not decrease during the 3 years of experimentation but seasonal yields varied by as much as 70 percent of the average. The treatments affected residual yields obtained more than 6 months after the experiment was terminated.

The application of 800 pounds of N as ammonium sulfate per acre annually over a 3-year period caused a drop of 3 pH units and a loss of 10.4 m.e. of exchangeable bases per 100 gm. of soil in the upper 6 inches of soil.

RESUMEN

Se estudió el efecto de aplicaciones de nitrógeno que variaban entre 0 y 2,000 libras por cuerda por año y de intervalos de corte de 40, 60, y 90 días, en el rendimiento y composición de la yerba Napier, o Elefante (*Pennisetum purpureum* Schum.), y en la acidez del suelo durante 3 años consecutivos.

Los rendimientos aumentaron con niveles de nitrógeno hasta 800 libras por cuerda por año. El contenido y rendimiento de proteína aumentó con niveles de nitrógeno hasta 2,000 libras por cuerda por año. Se recuperó en el forraje más del 60 por ciento del nitrógeno aplicado hasta 1,200 libras por cuerda, pero la eficiencia de utilización expresada en términos de

forraje seco producido por cada libra de nitrógeno disminuyó cuando se aplicaron más de 400 libras por cuerda. El contenido de fósforo y potasio disminuyó pero el de lignina aumentó al aumentar los niveles de nitrógeno. El contenido de calcio y magnesio en el forraje no se afectó señaladamente con las aplicaciones de nitrógeno.

Los rendimientos de forraje seco y de proteína, y el contenido de lignina del forraje aumentó al alargarse los intervalos de corte. Sin embargo, el contenido de proteína, fósforo, calcio, magnesio, y potasio disminuyó según se alargaron los intervalos de corte.

Con un intervalo de corte de 60 días y 800 libras de nitrógeno por cuerda por año, que parece ser el tratamiento óptimo, la yerba Napier produjo 44,561 libras de materia seca (como 130 toneladas de forraje verde) por cuerda por año, con un contenido de proteína de 9.7 por ciento. Con este tratamiento, la yerba extrajo del suelo 674 libras de nitrógeno, 554 libras de potasio y 120 libras de calcio, magnesio, y fósforo por cuerda por año.

El rendimiento no disminuyó durante los 3 años de experimentación, pero la producción varió hasta un 70 por ciento del promedio durante distintas épocas del año. Los tratamientos afectaron el crecimiento de la yerba aún hasta 6 meses después de terminar los experimentos.

La aplicación de 800 libras de nitrógeno, en forma de sulfato amónico, por cuerda por año, durante 3 años, redujo el pH de las 6 pulgadas de superficie hasta 3 unidades completas y acarreó una pérdida de 10.4 miliequivalentes de bases intercambiables por cada 100 gramos de suelo.

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