Effects of Five Nitrogen Sources on Yield and Composition of Napier Grass[1]

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INTRODUCTION

Napier grass (*Pennisetum purpureum*) responds strongly in yield and protein content to applications of up to 800 pounds of nitrogen per acre yearly in the Humid Region of Puerto Rico as shown by Caro, Vicente, and Figarella (*1*)[3] and Vicente, Silva, and Figarella (*4*), and with irrigation in the semiarid region as shown by Little, Vicente, and Abruña (*2*). There is limited information on the effects of the various nitrogen sources on yields and composition of grasses under humid tropical conditions.

This paper presents the results of a study of the effects of five nitrogen sources on yield and composition of Napier grass under conditions typical of much of the humid Tropics.

MATERIALS AND METHODS

The experiment was carried out at Orocovis in the humid Mountain Region of Puerto Rico over a 3-year period. Mean annual temperature is about 75° F. with seasonal variations of about 10° F. Highest daily temperatures rarely exceed 85° F. or fall below 65° F. Annual rainfall was 80.1, 59.8, and 74.4 inches for the 3 years of experimentation. Rainfall was fairly well distributed with lowest precipitation from December through March.

The soil is Catalina clay, a deep, red, latosol with 4.5 percent of organic matter, 0.25 of nitrogen, 16 m.e. of exchange capacity, and 8.1 m.e. of exchangeable bases per 100 gm. of soil, a volume-weight of 1.0, and a pH of 5.0 in the upper 6 inches. Clay, mineral-type, is predominantly kaolinitic with a high free iron oxide content.

The upper 6 inches of soil in all plots was maintained at approximately pH 6.0 throughout the experiment by liming in accordance with annual pH determinations. Two hundred pounds of P_2O_5 from 20-percent superphosphate were applied to all plots at the start of the experiment. Six hundred pounds of potassium, as potassium sulfate, and of nitrogen were applied per acre yearly to all plots in six equal applications. In all cases

[1] This paper covers work carried out cooperatively by the Soil and Water Conservation Research Division, Agricultural Research Service, USDA, and the Agricultural Experiment Station of the University of Puerto Rico.

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[3] Italic numbers in parenthesis refer to Literature Cited page 105–6.

the potassium sulfate provided abundant sulfur to meet the needs of the grasses for this nutrient.

Nitrogen sources tested were ammonium sulfate, sodium nitrate, urea, ammonium hydroxide, and ammonium nitrate. The soil was wet down immediately after application of the ammonium hydroxide to insure penetration and reduce losses by volatilization.

A randomized block design was used with all treatments replicated four times. Plots were 10 × 15 feet in size surrounded by ditches to prevent

TABLE 1.—*The effect of 5 sources of nitrogen on yield and composition of well-fertilized Napier grass cut every 60 days over a 3-year period at Orocovis*

N source	Yields per acre yearly		Composition on a dry-weight basis				
	Dry forage	Crude protein	Crude protein (N × 6.25)	Ca	P	K	Mn
	Pounds	*Pounds*	*Percent*	*Percent*	*Percent*	*Percent*	*P.p.m.*
Ammonium sulfate	30,372	2,408	7.9	0.36	0.11	3.67	182
Sodium nitrate	27,185	2,375	8.7	.37	.13	3.63	190
Urea	26,095	2,048	7.8	.35	.13	3.74	185
Ammonium hydroxide	28,135	1,972	7.0	.32	.12	3.80	170
Ammonium nitrate	27,940	2,305	8.2	.35	.12	3.89	161
Average	27,945	2,222	8.0	0.35	0.12	3.71	184
L.S.D. .05[1]	N.S.	178	0.59	N.S.	N.S.	N.S.	N.S.
0.01	N.S.	250	0.82	N.S.	N.S.	N.S.	N.S.

[1] N.S. = not significant.

fertilizer from washing into adjoining plots. A dense stand of Napier grass was established and maintained in all plots throughout the experiment.

The Napier grass was cut every 60 days, weighed, and the forage removed from the plots. Samples from each plot at every harvest were analyzed for dry matter and crude protein (N × 6.25). Samples were composited by plots yearly and analyzed for calcium, potassium, phosphorus, and manganese.

RESULTS AND DISCUSSION

Table 1 shows that nitrogen sources caused no significant differences in yield which averaged 27,945 pounds of dry forage per acre yearly.

The nitrogen sources also did not appreciably affect the calcium, potassium, phosphorus, or manganese content of Napier grass.

On the other hand, crude protein yields were significantly lower with urea and ammonium hydroxide, showing that nitrogen from these sources was utilized less efficiently by Napier grass. The higher loss of nitrogen from these sources, apparent during all 3 years of experimentation, was probably caused by greater losses from volatilization. Ammonium hydroxide also resulted in the lowest protein content in the forage.

It may be of interest to note that plots receiving nitrogen as ammonium-nitrate-limestone (ANL), added to the experiment during the last year,

TABLE 2.—*Seasonal effects on yield and protein content of well-fertilized Napier grass cut every 60 days over a 3-year period at Orocovis*

Year	Yields of dry forage per acre monthly			Protein content		
	May through August	September through December	January through April	May through August	September through December	January through April
	Pounds	*Pounds*	*Pounds*	*Percent*	*Percent*	*Percent*
First	4,420	2,360	1,840	7.0	9.3	9.8
Second	2,940	2,170	1,540	7.3	8.1	8.4
Third	2,380	1,680	1,330	7.3	9.0	10.0
Average	3,247	2,070	1,570	7.2	8.8	9.4
Monthly rainfall in inches	6.5	6.0	4.9			

produced yields of dry matter and protein similar to those of the ammonium nitrate plots.

In deciding on which nitrogen source to use, availability, cost per pound of nitrogen, and efficiency of utilization must all be considered. In addition, the lime required to neutralize residual acidity must also be taken into consideration. More limestone is required to neutralize the residual acidity of each pound of nitrogen from ammonium sulfate, while no lime is required with sodium nitrate which has a slightly basic residue.

The effects of these nitrogen sources on soil acidity and exchangeable base content were studied by Pearson, Abruña, and Vicente (*3*) who found that movement of bases through the profile was greater with the nitrogen sources having a stronger residual acidity. On the other hand, soil pH at all depths down to 2 feet was higher with sodium nitrate.

Table 2 shows that season of the year strongly affected yields and protein content of Napier grass. Yields were highest from May through August and

lowest during the "winter" months of January through April, with lower rainfall, cooler weather, and shorter days. Protein content of the forage was inversely proportional to yields because of the concentrating or diluting effect of yields in the presence of a uniform quantity of nitrogen. The forage contained over 2 percent more protein during winter than during seasons of flush growth.

SUMMARY

The effects of applying 600 pounds of nitrogen per acre yearly from five sources on yield and composition of Napier grass growing on a latosol in the humid Mountain Region of Puerto Rico over a 3-year period were determined.

Dry-matter yields and the calcium, phosphorus, manganese, and potassium content of the forage were unaffected by the nitrogen source. However, less protein was produced with urea and ammonium hydroxide than with ammonium sulfate, sodium nitrate, or ammonium nitrate, showing that the former are somewhat less efficient providers of nitrogen under the conditions of this experiment.

Forage yields were lower but protein content was higher during the "winter" months of lower rainfall, shorter days, and cooler weather.

RESUMEN

Se determinaron los efectos de aplicar 600 libras de nitrógeno por cuerda anualmente de cinco fuentes distintas sobre el rendimiento y composición de la yerba Napier.

Las fuentes de nitrógeno no causaron diferencias en el rendimiento o en el contenido de calcio, fósforo, potasio, y manganeso de la yerba. Sin embargo, la àplicàción de urea y hidróxido amoniacal resultaron en la producción de menos proteína que el sulfato amónico, el nitrato de sodio o el nitrato amónico, señalando que los compuestos mencionados primeramente son fuentes menos eficientes de nitrógeno, bajo las condiciones de este experimento.

Los rendimientos de forraje fueron menores, pero el contenido de proteína del forraje fué mayor durante los meses "invernales," con menos lluvia y con días más cortos y frescos.

LITERATURE CITED

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