# Effects of Seeding Rates and Methods on the Establishment and Yield of Common Guinea Grass[1]

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**ABSTRACT**

**The effects of three seeding rates (3.36, 6.72, and 10.08 kg of clean seeds per ha) and two planting methods (row and broadcast), with and without seedbed firming, on the establishment and yield (green forage, dry forage, and crude protein), of common Guinea grass (*Panicum maximum* Jacq.) were evaluated for 370 days in an Ultisol. Seeding rates influenced significantly the dry forage and crude protein yields of Guinea grass during the first 3 months of growth. The high rate (10.08 kg/ha) significantly increased dry forage yields by 22 and 49% over the medium (6.72 kg/ha) and low (3.36 kg/ha) seeding rates, respectively. The medium rate significantly increased dry forage and crude protein yields by 23 and 26% over the low seeding rate. Row planting was significantly better than broadcast planting only during the first 3 months of growth, increasing dry forage yields by 23% and crude protein yields by 17%. Seedbed firming after planting did not affect yields either during the first 3 months of growth or over the entire period of study (9 cuttings). During 370 days (9 cuttings) the high and medium seeding rates did not differ significantly with respect to yields; however, both outyielded significantly the low seeding rate. The highest yields were obtained with treatments that combined high seeding rate with row planting. The number of tufts varied among treatments from 4 to 6 per $m^2$. Mean crude protein, P, K, Ca, and Mg contents in the harvested forage were 11.21, .28, 3.13, .75 and .19%, respectively. It was concluded that, a good stand of Guinea grass can be obtained in 3 months when sown in August with 6.72 kg/ha of processed seeds or 33.6 kg/ha of unprocessed seeds.**

## INTRODUCTION

Guineagrass (*Panicum maximum* Jacq.) plays a very important role in grassland improvement and livestock production in Puerto Rico, especially on the south coast. Although considerable information is available about Guinea grass response to fertilizer levels, cutting heights, and grazing intensities (1, 3, 4, 5, 9), little is known about the establishment of this grass by seed.

Guinea grass is established either from crown sections of grass tufts or seeds. The tuft method is uneconomical and the latter is limited by the scarcity of viable seeds; germination is only approximately 5% (14). However, the germination rate can be increased by harvesting the seeds from 18 to 22 days after anthesis (7) and by air separation of the empty spikelets from the full ones. Vélez-Santiago et al. (12) reported that

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Guinea cultivars PR PI 3622 and 5857 were better seed yielders and produced more viable seeds in Puerto Rico than common Guinea grass.

In Cuba, Padilla et al. (8) reported that a Guinea grass stand can be established in natural *Andropogon* pastures with 15 to 20 kg per ha of seeds. In Australia, Graham (6) recommended 4.44 kg of cleaned seeds[3] per ha.

Information on seeding methods and establishment of Guinea grass in Puerto Rico is needed. Therefore, this study was undertaken to measure the effects of three seeding rates (3.36, 6.72, and 10.08 kg of cleaned seeds per ha), two planting methods (row and broadcast), and soil firming versus nonfirming, on green forage (GF), dry forage (DF), and crude protein (CP) yields of Guinea grass.

## MATERIALS AND METHODS

Ten-month-old common Guinea grass seeds were brought from a local source at $4.40 per kg. After passing them through a Clipper machine,[4] 45 kg of commercial seed yielded 9 kg of clean seed. Germination of clean seed was tested in greenhouse flats containing an Ultisol; 16 1-g samples were planted.

The field experiment was hand-seeded August 10, 1978. Clean seed rates of 3.36, 6.72 and 10.08 kg per ha were used, equivalent to 16.8, 33.6, and 50.4 kg per ha of uncleaned seeds, respectively. Seeding rates were combined with two methods of planting (row and broadcast) and with soil firming and nonfirming, resulting in 12 treatments in a partially balanced incomplete block design with 4 replicates. The soil series was a Corozal clay (subgroup Aquic Tropudults) with a pH of approximately 5.5. At soil preparation, lime was incorporated at a rate of 2.24 t/ha. Plot size was 3.2 × 6.7 m. Rows were .46 m apart (7 rows per plot) and seed placement was at 2- to 3-cm depth. Broadcast planting was done by hand sowing on the soil surface. The seedbed was firmed in half of the plots by rolling with a 55-gal drum, half filled with water, immediately after planting.

Overhead irrigation was applied on alternate days after sowing to ensure good germination. No irrigation was used after establishment of the grass.

All plots were cut by machete at a height of 23 cm above ground level on November 8, 1978, 3 mo after planting. Thereafter, 8 more cuttings

[3] Clean seed is considered to be full spikelets after separating 80% of the empty spikelets from a given weight of seed utilizing a cleaner separator, whereas total seeds mean full and empty spikelets together.

[4] Trade names in this publication are used only to provide specific information. Mention of a trade name does not constitute a warranty of equipment or materials by the Agricultural Experiment Station of the University of Puerto Rico, nor is this mention a statement of preference over other equipment or materials.

were harvested every 35 days for a period of 280 days. The grass was fertilized at a rate of 3.36 t/ha/yr with a 15-5-10 analysis in eight equal applications after each cutting. The forage was weighed, sampled, dried at 55° C in a forced-air oven, and ground in a Wiley mill to pass through a 1-mm screen. Dry matter (DM) content was determined for all samples.

For each treatment, CP determinations were conducted on first harvest samples, but CP, phosphorus (P), potassium (K), calcium (Ca), and magnesium (Mg) contents were determined by analyses of replicated composite samples from the 9 cuttings combined. Samples were subjected to sulfuric acid digestion (10) before N, P, and K determinations with a Technicon auto analyzer, and to Ca and Mg determinations with flame photometry (2). CP was calculated as N × 6.25.

During the first 3 mo of growth (August 10 through November 8, 1978), total rainfall was 400 mm. From November 9, 1978 to August 15, 1979 (8 cuttings), total rainfall was 1971 mm.

TABLE 1.—*Effect of three seeding rates on mean green forage, dry forage, and crude protein yields of Guinea grass during the initial 90-day growth period*

| Seeding rate | Green forage yield | Dry forage yield | Crude protein yield |
|---|---|---|---|
| *kg/ha* | *kg/ha* | *kg/ha* | *kg/ha* |
| 10.08 | 21,272 a[1] | 4,182 a | 548 a |
| 6.72 | 17,767 b | 3,437 b | 447 b |
| 3.36 | 13,761 c | 2,793 c | 353 c |

[1] Mean values in the same column followed by a, b or c differ significantly at the 5% probability level.

The data from the first cutting and from the 9 cuttings combined were analyzed separately. Data on GF, DF, and CP yields and DM contents were subjected to analysis of variance and compared by Duncan's multiple range test (11).

## RESULTS AND DISCUSSION

In germination tests in the greenhouse, clean seed produced a mean of 21 seedlings per g. Vélez-Santiago et al. (12) obtained a mean of 114 seedlings per g from 271-day-old, unclean seed of the same variety. The low germination rate of clean seed from the commercial source was probably due to long storage time, adverse storage conditions or poor seed collection techniques.

Table 1 shows the GF, DF and CP yield data for the first 3 mo of growth (from August 10 through November 8, 1978). The high seeding rate (10.08 kg/ha) resulted in significantly better yields than the medium rate (6.72 kg/ha), and this in turn was significantly better than the low rate (3.36 kg/ha), irrespective of the method of planting. Percentage yield

increases were 22 and 49% for the high rate over the medium and low seeding rates, respectively. The medium rate increased DF and CP yields by 23 and 26% over the low seeding rate. Row planting was significantly better than broadcast planting only during the first 3 mo of growth (table 2). Dry forage yields were increased by 23% and crude protein yields by 17% because of row planting. Seedbed firming after planting did not affect yields either during the first 3 months of growth or during the entire 370-day study of 9 cuttings.

TABLE 2.—*Effect of seeding method on mean green forage, dry forage and crude protein yields of Guinea grass during the initial 90-day growth period*

| Planting method | Green forage yield | Dry forage yield | Crude protein yield |
|---|---|---|---|
| | *kg/ha* | *kg/ha* | *kg/ha* |
| Rows | 19,430 a[1] | 3,833 a | 485 a |
| Broadcast | 15,770 b | 3,109 b | 414 b |

[1] Mean values in the same column followed by a or b differ significantly at the 5% probability level.

TABLE 3.—*Mean green forage, dry forage, and crude protein yields and dry matter content of Guinea grass during the initial 90-day growth period*

| Treatment | Identification | | Green forage yield | Dry matter content | Dry forage yield | Crude protein yield |
|---|---|---|---|---|---|---|
| | | | *kg/ha* | % | *kg/ha* | *kg/ha* |
| 1 | 3.36 kg seed/ha | RF[1] | 16,767 bd[2] | 20.6 a | 3,395 ab | 435 ac |
| 2 | 6.72 kg seed/ha | RF | 20,199 ab | 19.0 a | 3,791 ab | 486 ab |
| 3 | 10.08 kg seed/ha | RF | 23,948 a | 19.6 a | 4,708 a | 598 a |
| 4 | 3.36 kg seed/ha | BF | 11,702 d | 19.0 a | 2,182 c | 257 c |
| 5 | 6.72 kg seed/ha | BF | 16,477 bd | 18.2 a | 2,977 bc | 423 ac |
| 6 | 10.08 kg seed/ha | BF | 17,562 bd | 19.0 a | 3,308 bc | 443 ac |
| 7 | 3.36 kg seed/ha | RNF | 13,022 cd | 18.8 a | 2,545 bc | 355 bc |
| 8 | 6.72 kg seed/ha | RNF | 15,764 bd | 19.9 a | 3,124 bc | 405 ac |
| 9 | 10.08 kg seed/ha | RNF | 24,107 a | 18.8 a | 4,722 a | 550 ab |
| 10 | 3.36 kg seed/ha | BNF | 14,579 bd | 21.7 a | 3,319 bc | 412 ac |
| 11 | 6.72 kg seed/ha | BNF | 19,156 ab | 20.5 a | 3,915 ab | 486 ab |
| 12 | 10.08 kg seed/ha | BNF | 17,916 bc | 20.1 a | 3,662 ab | 543 ab |

[1] RF, row firmed; BF, broadcast firmed; RNF, row not firmed; BNF, broadcast not firmed.

[2] Mean values in the same column followed by one or more letters in common do not differ significantly at the 5% probability level.

Table 3 shows the forage and CP yields for each of the 12 treatments during the first 3 months of growth. Dry forage and CP yields ranged from 2,182 and 257 kg/ha to 4,708 and 598 kg/ha for treatments 4 and 3, respectively. The highest yields were obtained in those treatments with high seeding rate in row planting.

Table 4 shows the effect of the three seeding rates on the mean GF, DF and CP yields for the total of 9 cuttings over a period of 370 days. Over this period the high and medium seeding rates did not differ significantly in yields; however, both outyielded significantly the low seeding rate. The equality in GF, DF, and CP yields between the high and medium seeding rates from the 3rd to the 12th mo can be attributed

TABLE 4.—*Effect of three seeding rates on mean green forage, dry forage, and crude protein yields of Guinea grass during a 370-day period*

| Seeding rate | Green forage yield | Dry forage yield | Crude protein yield |
|---|---|---|---|
| | *kg/ha* | *kg/ha* | *kg/ha* |
| 10.08 | 170,953 a[1] | 31,059 a | 4,089 a |
| 6.72 | 168,988 a | 30,088 a | 3,961 a |
| 3.36 | 152,990 b | 27,465 b | 3,412 b |

[1] Mean values in the same column followed by a or b differ significantly at the 5% probability level.

TABLE 5.—*Mean green forage, dry forage, and crude protein yields and dry matter content of Guinea grass during a 370-day period*

| Treatment | Identification | | Green forage yield | Dry matter content | Dry forage yield | Crude protein yield |
|---|---|---|---|---|---|---|
| | | | *kg/ha* | % | *kg/ha* | *kg/ha* |
| 1 | 3.36 kg seed/ha | RF[1] | 159,316 ac[2] | 18.19 ab | 28,505 ab | 3,606 ab |
| 2 | 6.72 kg seed/ha | RF | 169,416 ac | 18.25 ab | 30,895 a | 4,035 ab |
| 3 | 10.08 kg seed/ha | RF | 177,703 ab | 17.95 ab | 31,745 a | 4,118 ab |
| 4 | 3.36 kg seed/ha | BF | 138,899 c | 17.92 ab | 24,463 b | 2,975 b |
| 5 | 6.72 kg seed/ha | BF | 172,102 ab | 17.49 b | 29,772 ab | 4,262 a |
| 6 | 10.08 kg seed/ha | BF | 170,242 ac | 18.25 ab | 30,454 ab | 4,088 ab |
| 7 | 3.36 kg seed/ha | RNF | 154,000 bc | 18.15 ab | 27,777 ab | 3,687 ab |
| 8 | 6.72 kg seed/ha | RNF | 161,275 ac | 18.27 ab | 28,863 ab | 3,695 ab |
| 9 | 10.08 kg seed/ha | RNF | 187,440 a | 18.06 ab | 33,454 a | 3,918 ab |
| 10 | 3.36 kg seed/ha | BNF | 159,280 ac | 18.40 ab | 29,259 ab | 3,509 ab |
| 11 | 6.72 kg seed/ha | BNF | 163,986 ac | 18.35 ab | 29,721 ab | 3,621 ab |
| 12 | 10.08 kg seed/ha | BNF | 158,064 ac | 18.97 a | 29,492 ab | 4,336 a |

[1] RF, row firmed; BF, broadcast firmed; RNF, row not firmed; BNF, broadcast not firmed.

[2] Mean values in the same column followed by one or more letters in common do not differ significantly at the 5% probability level.

to the formation of thicker clumps where the medium rate was applied. The variables, rows vs. broadcast and firming the soil after planting, were not significant during the 370-day period.

Table 5 shows the mean GF, DF and CP yields of individual treatments for all 9 cuttings during the 370-day period. Over this period, treatments 2, 3 and 9 outyielded significantly treatment 4 in DF; the other differences

among treatments were small and non-significant. Figure 1 shows the relationship among the different treatments in DF yield, both during the first 3 mo and the subsequent 9 mo. Treatments 5, 6, 7, 8 and 10, which were significantly inferior to treatments 3 and 9 during the former period, were not significantly inferior during the latter period. The mean dry

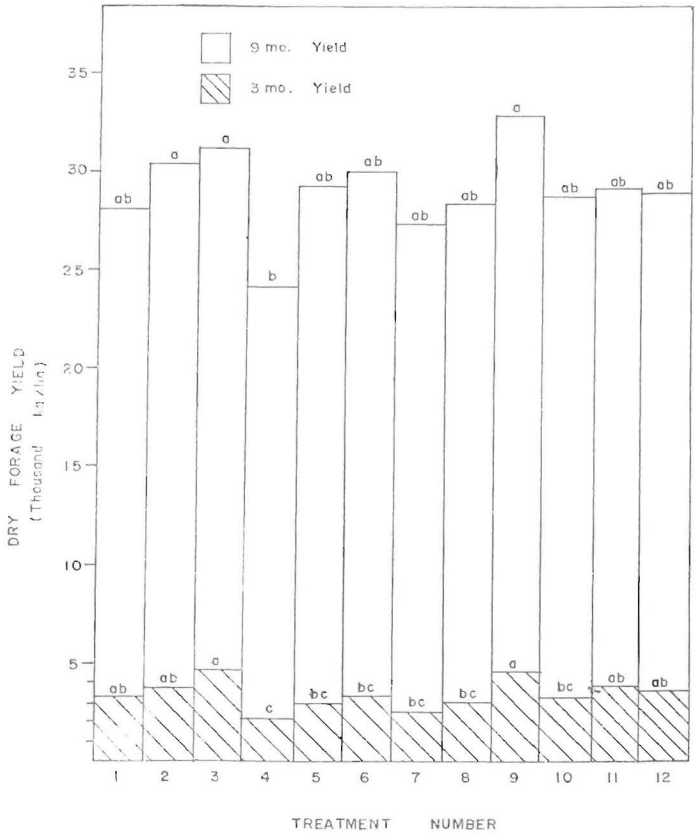


FIG. 1.—Effect of 3 seeding rates and 2 planting methods with soil firming and not firming on the establishment and yields of common Guinea grass. Letters at top of columns indicate statistical differences among treatments.

matter content of the forage for the 9 cuttings was 18.19%. None of the variables studied affected this parameter.

The number of tufts varied among treatments from 4 to 6 per $m^2$. Overall mean CP, P, K, Ca and Mg contents were 11.21, .28, 3.13, .75 and .19%, respectively (table 6).

Annual DF and CP yields from Guinea grass cut every 35 days in the present study compared favorably with those of star grass and other

promising *Cynodon* species cut every 60 days in previous experimentation in the same region (13).

Although the criteria of forage and crude protein yields favor a high seeding rate during the first 3 mo of growth, data encompassing a full year indicate no differences between high and medium seeding rates.

It is concluded that under the conditions of this research, a seeding rate of 6.72 kg/ha of clean seed or 33.6 kg of unprocessed seed, either in rows or broadcast, is adequate to obtain a good stand of Guinea grass in 3 mo, when seeded in August. Fewer seeds can provide an adequate stand, if the seeds are picked 18 to 20 days after anthesis and sown 6 to 7 mo later.

TABLE 6.—*Mean crude protein, phosphorous, potassium, calcium, and magnesium contents of Guinea grass harvested every 35 days*

| Treatment | Identification | | CP | P | K | Ca | Mg |
|---|---|---|---|---|---|---|---|
| | | | | | % | | |
| 1 | 3.36 kg seed/ha | RF[1] | 10.97 | 0.28 | 3.11 | 0.71 | 0.19 |
| 2 | 6.72 kg seed/ha | RF | 11.88 | .27 | 3.30 | .76 | .19 |
| 3 | 10.08 kg seed/ha | RF | 10.88 | .27 | 3.07 | .76 | .19 |
| 4 | 3.36 kg seed/ha | BF | 12.04 | .29 | 3.19 | .76 | .18 |
| 5 | 6.72 kg seed/ha | BF | 10.91 | .28 | 2.86 | .79 | .19 |
| 6 | 10.08 kg seed/ha | BF | 11.00 | .28 | 3.19 | .71 | .17 |
| 7 | 3.36 kg seed/ha | RNF | 11.63 | .29 | 3.17 | .74 | .20 |
| 8 | 6.72 kg seed/ha | RNF | 11.13 | .30 | 3.03 | .76 | .20 |
| 9 | 10.08 kg seed/ha | RNF | 10.60 | .27 | 3.12 | .76 | .20 |
| 10 | 3.36 kg seed/ha | BNF | 11.13 | .28 | 3.15 | .77 | .21 |
| 11 | 6.72 kg seed/ha | BNF | 11.54 | .30 | 3.24 | .71 | .17 |
| 12 | 10.08 kg seed/ha | BNF | 10.81 | .29 | 3.09 | .71 | .18 |

[1] RF, row firmed; BF, broadcast firmed; RNF, row not firmed; BNF, broadcast not firmed.


## RESUMEN

Se evaluó la yerba guinea común (*Panicum maximum* Jacq.) en tres cantidades de semilla limpia (3.36, 6.72 y 10.08 kg/ha) en surcos y a voleo, y en suelo afirmado y sin afirmar, para rendimiento de forraje verde, forraje seco y proteína bruta durante 370 días consecutivos. Las tres cantidades fueron equivalentes a 16.8, 33.6 y 50.4 kg/ha de semillas sin limpiar, ya que 4/5 partes de las semillas vanas se separaron de un lote de semillas sin limpiar (llenas y vanas). Los tratamientos en surcos consistieron de 7 surcos a 0.46 m entre sí y a 2 a 3 cm de profundidad. Las semillas se sembraron a mano el 10 de agosto de 1978 y el primer corte de forraje se hizo 3 meses después. Luego se hicieron 8 cortes cada 35 días en 280 días. Se analizaron estadísticamente los datos del primer corte y los de los 9 cortes en conjunto.

Durante el primer corte (a los 90 días) los rendimientos de forraje seco y proteína bruta se beneficiaron de las altas cantidades de semillas que se sembraron. La más alta (10.08 kg/ha) produjo aumentos significativos (22 y 49%) en los rendimientos de forraje seco sobre la mediana (6.72 kg/ha) y la más baja (3.36 kg/ha), respectivamente. La siembra en surcos superó a la siembra a voleo solamente durante los primeros 3 meses de crecimiento. Esta práctica benefició en un 23% los rendimientos de forraje seco y en un 17% los de proteína bruta sobre la siembra a voleo. El afirmar o no afirmar el suelo inmediatamente después de sembrar no tuvo efecto positivo sobre los rendimientos de la yerba guinea, posiblemente porque la plantación no sufrió un deficit hídrico en el proceso de germinación, ya que se regó varias veces después de la siembra.

Durante los 370 días de estudio (9 cortes) los efectos de las cantidades alta y mediana de semilla fueron bastante similares con respecto al rendimiento de la yerba; pero ambas cantidades fueron superiores a la más baja. Esto se debió a que las macoyas con las cantidades mediana y alta de semilla aceparon más. La siembra en surcos o a voleo no benefició los rendimientos al cabo de los 370 días.

El número de macoyas varió de 4 a 6 por $m^2$ entre tratamientos. Los contenidos en proteína bruta, fósforo, potasio, calcio y magnesio fueron 11.21, .28, 3.13, .75 y .19%, respectivamente.

Se concluye que sembrando 6.72 kg/ha de semilla limpia ó 33.6 kg por ha de semilla sin limpiar se puede obtener una buena plantación de la yerba guinea común en 3 meses si se siembra en agosto. Posiblemente puede usarse menos semilla si se corta de 18 a 20 días después de la antesis y se siembra a los 6 ó 7 meses después de cosechar la semilla.

## LITERATURE CITED

1. Arroyo-Aguilú, J. A., S. Tessema, R. E. McDowell, P. J. Van Soest, A. Ramirez and P. R. Randel, 1975. Chemical composition and in vitro digestibility of five heavily fertilized tropical grasses in Puerto Rico, J. Agric. Univ. P. R. 59 (3): 186–98.
2. Burriel-Martí, F. and J. Ramírez-Muñoz, 1960. Flame photometry, a manual of methods and application, 3rd rep., Elsevier Publ. Co., Amsterdam, Holland.
3. Caro-Costas, R. and J. Vicente-Chandler, 1961. Effects of two cutting heights on yields of five tropical grasses, J. Agric. Univ. P. R. 45 (1): 46–9.
4. ——, J. Vicente-Chandler and C. Burleigh, 1961. Beef production and carrying capacity of heavily fertilized, irrigated Guinea, Napier, and Pangola grass pastures on the semiarid south coast of Puerto Rico, J. Agric. Univ. P. R. 45 (1): 32–6.
5. ——, —— and J. Figarella, 1965. Productivity of intensively managed pastures of five grasses on steep slopes in the humid mountains of Puerto Rico, J. Agric. Univ. P. R. 49 (1): 99–111.
6. Graham, T. F., 1946. Grassland development in tropical coastal areas, Queensl. Agric. J. 63 (5): 261–9.
7. Padilla, C. and G. Febles, 1976. Determination of the optimum harvesting data for Guinea grass seed (*Panicum maximum* Jacq.), Cuban J. Agric. Sci. 10 (1): 117–35.
8. ——, L. Sánchez, J. Sarroca and G. Febles, 1978. Effect of planting methods on the

establishment of *Panicum maximum* Jacq. on natural pastures, Cuban J. Agric. Sci. 12 (2): 205–16.

9. Little, S., J. Vicente and F. Abruña, 1959. Yield and protein content of irrigated Napiergrass, Guineagrass and Pangolagrass as affected by nitrogen fertilization, Agron. J. 51 (2): 111–3.
10. Riera, A., 1955. The methods of foliar diagnosis as applied to sugarcane, II, The chemical analysis of sugarcane leaf samples, Agric. Exp. Stn. Univ. P. R. Bull. 123, pp. 23–32.
11. Snedecor, G. W. and W. G. Cochran, 1967. Statistical methods, 6th ed, The Iowa State Univ. Press, Ames, Iowa.
12. Vélez-Santiago, J., 1972. Efecto de Niveles de Abono y Densidades Poblacionales en la Producción de Cariópsides (semilla) en la Yerba Guinea, *Panicum maximum* Jacq., M. S. Thesis, Univ. P. R., Mayagüez, P. R.
13. ——, A. Sotomayor-Ríos and S. Torres-Rivera, 1979. Effects of three harvest intervals and two fertilizer rates on the yield and HCN content of ten *Cynodon* cultivars, J. Agric. Univ. P. R. 63 (1): 35–44.
14. Vicente-Chandler, J., F. Abruña, R. Caro-Costas, J. Figarella, S. Silva and R. W. Pearson, 1974. Intensive grassland management in the humid tropics of Puerto Rico, Agric. Exp. Stn. Univ. P. R. Bull. 238.