Potential of *Panicum maximum* as a source of energy

LIANA JANK[1], EDSON A. DE LIMA[2], ROSANGELA M. SIMEÃO[1] AND RONIMAR C. ANDRADE[3]

[1]*Empresa Brasileira de Pesquisa Agropecuária, Embrapa Gado de Corte, Campo Grande, MS, Brazil.* www.cnpgc.embrapa.br
[2]*Empresa Brasileira de Pesquisa Agropecuária, Embrapa Florestas, Colombo, PR, Brazil.* www.cnpf.embrapa.br
[3]*Universidade Anhanguera Uniderp, Campo Grande, MS, Brazil.* www.uniderp.br

Keywords: DM yield, cellulose, lignin, combustion power.

Introduction

The use of plant biomass as a source of energy presents many advantages, mainly that it is a renewable, clean source of energy. Many tropical grasses have excellent potential as energy crops. The main one in Brazil is *Pennisetum purpureum* (elephant grass) owing to its very high yields. However, it is vegetatively propagated, thus more difficult to establish than seed-propagated species. The use of *Panicum maximum* (guinea grass) is a possible alternative for use as a source of energy, due to its high yields as well as seed propagation. The objective of this research was to evaluate the potential of different *P. maximum* genotypes for use as energy crops, in comparison with elephant grass.

Methods

Fourteen *P. maximum* genotypes (guinea grass), including 3 commercial varieties (cvv. Milênio, Mombaça and Tobiatã), and *P. purpureum* cv. Napier (elephant grass) were evaluated at Embrapa Beef Cattle in Campo Grande, MS, Brazil, in a randomized block design with 3 replications. The soil was a dark red latosol fertilized with 50 kg/ha P_2O_5 (superphosphate) and 50 kg/ha K_2O (potassium chloride) at planting**.** Plots consisted of 4 rows, 3 m long, spaced 0.5 m apart. Genotypes were seeded in November 2007 and cut at 20 cm from the soil in March 2008. Every 120 days thereafter, plots were harvested at 20 cm from the soil, the cut material was weighed and a sample taken, which was weighed and separated into plant parts: leaf, stem and dead matter. After drying at 65 °C for 3 days, leaf and stem samples were ground through a 1 mm screen and evaluated for quality through NIRS (Near-Infrared Reflectance Spectroscopy). A ground sample of each was sent to Embrapa Forestry, in Curitiba, PR, Brazil, for evaluation of combustion power in a digital adiabatic calorimeter, according to NBR 8633 (Associação Brasileira de Normas Técnicas 1984). Data were analyzed by SAS.

Results and Discussion

The elephant grass (cv. Napier) produced 30.6 t/ha/yr dry matter (DM) (Table 1), less than the levels obtained by Urquiaga et al. (2006) in Brazil, who obtained at least 30 t/ha of stems with a minimal application of fertilizers and N from biological N fixation. *Panicum maximum* yields were lower and varied from 13.8 to 21.4 t/ha/yr. The yields recorded for guinea grass are much lower than the 49.1 t/ha in 9 months growth on a dark red latosol fertilized with 60 kg N/ha, 60 kg K_2O/ha and 60 kg P_2O_5/ha reported by Fernandes et al. (2009). Leaf percentage in the guinea grass genotypes (range 51.7−71.5%) was higher than the 48.3% for Napier. Culm yield of Napier was very high (18.1 t/ha/yr), compared with a maximum of 10.5 t/ha for *P. maximum.*

In general, elephant grass presented the highest neutral detergent fiber (NDF) and lowest lignin concentrations in leaves (Table 1), and the highest crude protein (CP) and lowest cellulose in stems (Table 2). For second-generation ethanol production, cultivars with the highest cellulose concentrations and lowest lignin concentrations are desirable. Second-generation ethanol is produced from plant biomass, which is mainly composed of cellulose, a polymer formed by chains of glucose. The breakdown of cellulose into simple glucose molecules allows microorganisms to ferment this simple sugar and subsequently ethanol is produced. On this basis, the guinea grass genotypes are preferable, because of their higher cellulose concentrations in leaves (mean of 29.5%, Napier 28.8%) and stems (mean of 35.6%, Napier 31%). These cellulose concentrations agree with those obtained

Correspondence: Liana Jank, Embrapa Gado de Corte, Avenida Rádio Maia, 830 − Zona Rural, Campo Grande CEP 79106-550, MS, Brazil.
Email: liana.jank@embrapa.br

by Morais et al. (2009), but are lower than the 41.2% for elephant grass culms fertilized with 100 kg N/ha (as urea), split 1/3 at planting and 2/3 after 50 days (Quesada et al. 2004).

Table 1. Yield and quality of 14 *Panicum maximum* genotypes and *Pennisetum purpureum* cv. Napier.

Genotype	DM (t/ha)	Leaf %	NDF	Cellulose	Lignin[1]	Cellulose yield (t/ha)	Lignin yield (t/ha)	Combustion power (%)
			% in leaves					
PM40	13.8	63.8	74.7	28.8	3.2	4.5	0.6	16.9
PM271	18.9	58.6	74.7	29.1	3.5	6.0	0.9	16.7
PM41	17.1	71.5	76.2	30.3	3.6	5.7	0.9	17.1
PM322	17.9	51.7	73.8	29.2	3.5	6.0	0.9	16.8
PM186	16.0	70.4	76.0	30.3	3.6	5.1	0.9	17.1
PM4	19.1	63.8	74.2	30.2	3.6	6.6	0.9	16.9
PM30	21.4	64.2	74.1	30.0	3.5	7.2	1.2	17.0
PM190	15.7	57.5	74.3	29.1	3.5	5.1	0.9	17.1
PM145	15.4	60.7	75.0	28.9	3.3	4.8	0.6	16.9
PM23	13.5	54.2	74.5	29.5	3.4	4.5	0.6	17.2
PM10	21.4	60.7	75.4	28.7	3.6	7.2	1.2	17.3
Milênio	20.3	57.4	74.6	28.9	3.6	6.6	1.2	17.0
Mombaça	19.4	64.1	74.4	29.3	3.5	6.6	0.9	16.7
Tobiatã	17.7	69.8	76.4	30.4	3.6	5.7	0.9	17.1
Napier	30.6	48.3	79.2	28.8	3.0	9.3	1.5	17.7
MSD[2]	3.9	6.0	1.1	0.7	0.2	4.5	0.3	0.5

[1]Extracted with sulphuric acid.
[2]Mean difference for significance by Waller-Duncan mean comparison.

Table 2. Quality characteristics of 14 *Panicum maximum* genotypes and *Pennisetum purpureum* cv. Napier.

Quality characteristic	*P. maximum* genotypes	*P. purpureum* cv. Napier
	(%)	
Leaf CP	10.9−12.4	11.9
Leaf digestibility	51.6−58.2	57.1
Stem CP	4.7−6.2	6.8
Stem digestibility	41.1–48.0	46.3
Stem NDF	77.9−79.9	78.0
Stem cellulose	35.0−36.3	31.0
Stem lignin	5.6−6.2	5.6

On the other hand, *P. maximum* genotypes presented slightly higher lignin concentrations in leaves (mean of 3.5%, Napier 3.0%) and stems (mean of 5.9%, Napier 5.6%). However, DM yield is an important consideration and the high yield obtained with Napier meant that total cellulose accumulated by Napier (9.3 t/ha/yr) (Table 1) was much higher than for *P. maximum* (4.5−7.2 t/ha/yr). The total quantities of lignin accumulated were also higher for Napier (1.5 t/ha/yr) than for guinea grass (0.6−1.2 t/ha/yr). Biomass may also be used for direct burning to produce charcoal. Elephant grass presented a higher combustion power (17.7%) than the guinea grass genotypes (16.7−17.3%); however, the difference was small (Table 1).

Conclusion

Our data indicate that guinea grass genotypes may be used as alternative sources of biomass for energy production as ethanol or charcoal. Six genotypes were most promising, including cv. Mombaça, and produced about two-thirds of the DM yield of Napier. The savings in planting from seed as opposed to cuttings would need to be weighed up against the reduced total production relative to elephant grass.

References

Associação Brasileira de Normas Técnicas. 1984. NBR 8633: Carvão vegetal: determinação do poder calorífico. Rio de Janeiro, Brazil.

Fernandes FD; Carvalho MAA; Ramos AAK; Guimarães R Jr; Martha GB Jr; Jank L. 2009. Evaluating *Panicum maximum* as an Energy Crop: Biomass Productivity. Proceedings of the II International Symposium on Forage Breeding. Embrapa Beef Cattle, Campo Grande, MS, Brazil.

Morais RF de; Souza BJ de; Leite JM; Soares LH de B; Alves BJR; Boddey RM; Urquiaga S. 2009. Elephantgrass genotypes for bioenergy production by direct biomass combustion. Pesquisa Agropecuária Brasileira 44: 133−140.

Quesada DM; Boddey RM; Reis VM; Urquiaga S. 2004. Parâmetros Qualitativos de Genótipos de Capim Elefante (*Pennisetum purpureum* Schum.) Estudados para a Produção de Energia através da Biomassa. Circular Técnica 8. Embrapa Agrobiologia, Seropédica, RJ, Brazil.

Urquiaga S; Alves BE; Boddey R. 2006. Capim Elefante: uma Nova Fonte Alternativa de Energia. (Retrieved 14 March 2013 from www.infobibos.com/Artigos/2006_2/capimelefante/Index.htm).