A Contribution to the Introduction of the High-Trunk Mulberry System in Tropical Climates

José Eduardo de Almeida

Estação Experimental de Zootecnia, Gália, São Paulo, Brasil

and

Tamara Canto Fonseca

Instituto de Zootecnia, Nova Odessa, São Paulo, Brasil

Introduction

Mulberry (*Morus* sp) has gained new grounds in the world scene as forage plant due to its high protein content and high digestibility (Baffi, 1992; Basaglia, 1993; Hara, 1993; Sugohara *et al*., 1994a,b; Takahashi et al., 1994; Sánchez, 1999; Schmidek, 1999). However, its management is not yet defined, and there are various alternatives when is destined to be used for domestic farm animals in general.

In Brazil, mulberry is known as a forage plant for the silkworm (*Bombyx mori* L.) and it is cultivated at approximate spacing of $1m^2$/plant, with cuts close to the ground at 91d-intervals (13 weeks).

The management of mulberry like a shrub or a tree has been encouraged by some experienced veterans knowledgeable of the practices utilised in Europe and Japan, like Mr. Giuseppe Briani, Mr. Marino Serpa and Mr. Mário Hashimoto. These experts argue on the advantages of the system, like: greater production, better exploitation of soil, better leaf quality, longer longevity and possibility of associated crops, in the limits of roads or property

boundaries. This is illustrated by a photo of more than 200-year old mulberry trees at Assisi, Italy, with a production, according with Mr. Briani, that reaches 15kg of leaves per tree/year.

This article is a contribution towards the studies of mulberry in this system.

Materials and Methods

The experiment was carried out at the Livestock Experimental Station at Galia, in the western part of São Paolo State (latitude 22°17'S , longitude 49°33'W), in sandy soil, acid and with low fertility. Mulberry was planted by stakes measuring 30cm in length and 1.5cm in diameter at 2 x 2m spacing in 1996. Each plot consisted in two lines of 5 plants, subdivided in two subplots of 5 plant. Production data was collected in the agricultural years of 1997-98 and 1998-99.

Table 1 - Description of the used clones and annual production (kg/ha) form the experiment by Fonseca et al. (1987c) by the stump system.

Clone	**Sex**	**Origin**	**Annual Production**
IZ 1/16	male	Fernão Dias x Catânia Paulista	-
IZ 3/2	female	Contadini x Catânia Paulista	-
IZ 6/7	female	Lopes Lins x Catânia Paulista	-
IZ 10/1	male	Lopes Lins x Catânia Paulista	-
IZ 10/4	male	Lopes Lins x Catânia Paulista	17,779
IZ 10/8	male	Lopes Lins x Catânia Paulista	19,289
IZ 11/9	female	Formosa x Kokuso 27	10,061
IZ 13/6	male	Fernão Dias x Kokuso 27	26,167
IZ 56/4	female	Formosa x Catânia Paulista	31,976
IZ 57/2	female	Formosa x Kokuso 27	24,490
IZ 40	female	Open pollination	25,730
KORIN	female	Mutation of Miura variety	-

The experimental design was split-plot, with 12 treatments, 11 improved clones from the Instituto de Zootecnia (Fonseca *et al.*, 1994) and a commercial clone as control (Table 1), and two subplots (cuts at 9 and 13 weeks) with 4 random blocks.

Obtained annual production data was utilised for comparison of management within harvest; among harvests; clone within management and clones within harvest, through non-parametric tests: Sing test, Wilcoxon's sign-rank test and Friedman's χ^2 test (Campos, 1983; Dagnelie, 1988; Hollander & Wolfe, 1973).

Results and Discussion

Table 2 presents annual production, in kg/plant, of the 12 clones subjected to cuts every 9 weeks (4 cuts per year) and every 13 weeks (3 cuts per year).

The analysis of the data of Table 2, one can observe that production data, in absolute numbers, is similar to that obtained in the stump system (Table 1), with the weakest clone producing 10,061kg/ha/year versus 9,812kg/ha/year in the high-trunk system with cuts every 9 weeks and 13,525kg/ha/year with cuts every 13 weeks (Table 2).

This results indicate the adaptation of the clones to the new system, taking into account that the high-trunk experiment was based on young tress, two years old, and that the improved clone show a significant interaction with the cuts. This shows an inadequate selection when based on few harvests (Fonseca et al., 1981).

The year effect was supported by the Sign Test, through the average results of the two managements a B = 3 was obtained, accepting H_0, with a level of significance of α=0,0193. At the same time, the year effects with management were significant, with reduction in production for 4 cuts per year (B = 2) and increases for 3 cuts per year (B= 1).

Table 2 - Annual production, in kg/plant, of 12 clones subjected to cuts every 9 or 13 weeks and mean annual production per ha (with 2.500 plants/ha)

	Cutting frequency					
Clones	**9 weeks (4 cuts)**			**13 weeks (3 cuts)**		
	1997/98	**1998/99**	**Annual mean**	**1997/98**	**1998/99**	**Annual mean**
	kg/plant	**kg/plant**	**kg/ha**	**kg/plant**	**kg/plant**	**kg/ha**
IZ 1/16	7.19	6.67	17,325	6.44	9.06	19,375
IZ 3/2	5.58	3.91	11,863	5.33	7.45	15,975
IZ 6/7	5.15	5.55	13,375	4.32	6.05	12,963
IZ 10/1	5.49	4.73	12,775	5.98	9.20	18,975
IZ 10/4	5.97	5.03	13,750	7.01	8.61	19,525
IZ 10/8	6.46	5.72	15,225	5.55	9.32	18,588
IZ 11/9	4.59	3.26	9,812	5.90	4.92	13,525
IZ 13/6	6.48	6.42	16,125	6.59	9.03	19,525
IZ 56/4	7.01	4.73	14,675	4.72	8.00	15,900
IZ 57/2	5.54	3.57	11,388	6.03	6.67	15,875
IZ 40	6.62	7.26	17,350	6.80	9.33	20,163
KORIN	6.81	5.36	15,213	6.62	9.43	20,063

These results suggest that cuts every 9 weeks are detrimental to the performance of the clones in the study, whereas management with cuts every 13 weeks allows the plants to show gradual production increases. This is understandable since the clones were selected within a cutting system of every 13 weeks (Fonseca et al., 1986; 1987a; 1987b; 1987c).

In order to confirm this assumption, the same test was applied for the two managements in the first year of production (1997/98) obtaining B = 6, therefor accepting H_0. In the second year, B = 0 was obtained, rejecting H_0. This indicates that during the first year, production per plant was the same for the two cutting frequencies and the fourth cuts of the 9 weeks frequency did not

increases total annual yield. In the second year, the residual effect of the two managements produced a reduction in yield in the 9-week frequency and an increase in the 13-week treatment (Table 2).

The same result was obtained when Wilcoxon's Sign-Rank test was applied. For the first year W = 0,404 (accepting H_0) and for the second year W = 3,002 (rejecting H_0).

Being one of the objectives of this work to indicate an appropriate clone for the proposed management system, the Kruskal-Wallis test [H = 12,7887 (ns) for 9 weeks and H = 12,1449 (ns) for 13 weeks] and the Friedman's χ^2 were applied to the performance of the 12 clones. It was shown that clones performed similarly, not presenting significant differences at α =0.05 level, in both cutting frequencies.

Conclusion

The clones responded well to the new production system with yields comparable to the stump method.

It was not possible in two years to select a superior clone among the 12 clones studies, as it was the intention.

References

Baffi, M. H. 1992. Utilização da amoreira (*Morus alba* L.), cultivar Yamada para caprinos: curva de crescimento e digestibilidade *in vitro.* UNESP - Campus de Jaboticabal, SP, Brasil, 35p. (Final work for graduation)

Basaglia, R. 1993. Eficiência da utilização da proteína da amoreira (*Morus alba* L.), para caprinos. UNESP - Campus de Jaboticabal, SP, Brasil, 45p. (Final work for graduation)

Campos, H. 1983. Estatística Experimental Não Paramétrica. 4ª ed., FEALQ, ESALQ/USP, Piracicaba, SP, Brasil.

Dagnelie, P. 1988. Théorie et Méthodes statistiques. Les Presse Agronomiques de Gembloux, Belgique. vol. 2.

Fonseca *et al*., 1981. Estimação de parâmetros visando à seleção de híbridos artificiais de amoreira. Boletim da Indústria Animal, Nova Odessa, SP, Brasil, 38(1):85-108.

Fonseca *et al*., 1986. Competição de híbridos naturais e artificiais de amoreira. Boletim da Indústria Animal, Nova Odessa, SP, Brasil, 43(2):367-373.

Fonseca *et al*., 1987a. Competição de híbridos artificiais de amoreira - II. Boletim da Indústria Animal, Nova Odessa, SP, Brasil, 44(2):315-322.

Fonseca *et al*., 1987b. Competição de híbridos naturais e artificiais de amoreira - III. Boletim da Indústria Animal, Nova Odessa, SP, Brasil, 44(2):323-328

Fonseca *et al*., 1987c. Competição de variedades, híbridos naturais e artificiais de amoreira - IV. Boletim da Indústria Animal, Nova Odessa, SP, Brasil, 44(2):329-334.

Fonseca, T. C.; Almeida, J. E.; and Okamoto, F. 1994. Le programme d'amelioration du mûrier dans L'état de São Paulo au Bresil. Sericologia, La Mulatiére, 34(4):727-733.

Hara, C.H. 1993. Produção e digestibilidade *in vitro* da matéria seca e proteína de cultivares de amoreira (*Morus alba* L.). UNESP - Campus de Jaboticabal, SP, Brasil, 1993. 40p. (Final work for graduation)

Hollander, M. and Wolfe, D. A. 1973. Nonparametrical statistical methods. New York, John Wiley & Sons.

Sánchez, M.D. 1999. Mulberry: a high forage available almost worldwide. World Animal Review. 93(2):36-46.

Schmidek, A. 1999. Composição bromatológica e degradabilidade em caprinos, de cultivares de amoreira (*Morus alba* L.) UNESP, Campus de Jaboticabal, SP, Brasil. 63p. (Final work for graduation)

Sugoraha, A., Resende, K.T., Takahashi, R., Magiario, K., and Reis, R.A. 1994a. Composição bromatológica da amoreira (*Morus alba* L.), cultivar Yamada, em diferentes idades de crescimento. Anais da XXXI Reunião Anual da SBZ, Maringá, PR, Brasil.

Sugohara, A., Resende, K. T., Takahashi, R., Guideli, C., Reis, R.A., and Vasconcelos, V.R. 1994b. Composição bromatológica de cultivares de amoreira (*Morus alba* L.). 3 – Estação de verão. Anais da XXXI Reunião Anual da SBZ, Maringá, PR, Brasil .

Takahashi, R., Sugoraha, A., Resende, K.T., Reis, R.A., and Vasconcelos, V.R. 1994. Produção e digestibilidade de cultivares de amoreira (*Morus alba* L.). 1 – Estação da primavera. Anais da XXXI Reunião Anual da SBZ, Maringá, PR, Brasil.