Production of barbatimão (Stryphnodendron adstringens) seedlings of increasing doses of domestic sewage effluent

Luiz Bruno Silva Constantino[1], Jayme Ferrari Neto[2], Beatriz Santos Machado[3], Fernando Jorge Correa Magalhães Filho[4], Denilson de Oliveira Guilherme[5]

[1]Graduate in agronomy, Dom Bosco Catholic University, Campo Grande/Mato Grosso do Sul
[2]Professor of agronomy graduate, Dom Bosco Catholic University, Campo Grande/Mato Grosso do Sul
[3,4,5]Postgraduate program in environmental sciences and agro-business sustainability, Dom Bosco Catholic University, Campo Grande/Mato Grosso do Sul.

Abstract— *The barbatimão is a traditional plant species of Brazilian cerrado. Barbatimão bark is widely used in the production of medicines and cosmetics. Because it is an extractive exploitation plant, the activity can be considered aggressive for plants that after having their shells removed may die. Another point to consider is the lack of a fertilization protocol. Aiming to improve the nutrition of barbatimão seedlings through the use of effluent of domestic exhaustion. This work had as objective to study the production of barbatimão seedlings in function of crescents doses of domestic exhaustion. The experiment was conducted in a randomized block design with 5 treatments and 10 replications. The seedlings were grown in plastic bags of 7.5 liters filled with substrates based on pinus bark. The biometric evaluations were initiated 30 days after transplanting when the plants were already established in the new container and consisted of: height of the plants (measured by means of millimeter ruler) being considered with initial point of the region of the collection until the apex of the seedling; diameter of the stem (measured by means of digital caliper) and number of leaves counted from the base to the apex of the plant, being considered as leaf the petiole of the composite leaf inserted in the branches of the plant. In general, it was concluded that barbatimão seedlings were negatively influenced by the addition of domestic effluent from household wastewater. However, studies with lower dosages than those tested in this study are suggested.*

Keywords—biomass, Agricultural production, nutritional management.

I. INTRODUCTION

The Stryphnodendron adstringens, popularly known as Barbatimão, bark of virginity, tiller beard, among other synonyms, is a species of the Brazilian Cerrado and transition zones with other biomes, occurring between the states of Bahia, Goiás, Mato Grosso, Mato Grosso do South, Minas Gerais, São Paulo, Tocantins and Distrito Federal (ALMEIDA et al., 1998; LORENZI, 2002).

The barbatimão has high pharmaceutical demand due to the high production of tannin that concentrates in a higher content mainly in the bark of the plant with about 25 to 30% of tannin in aqueous extract (PANIZZA et al., 1988).

The high demand for secondary metabolites such as tannin present in this species makes it subject to disorderly extractivism (BORGES FILHO et al., 2003). This in many Brazilian states does not have a management plan that regulates the part of the plant to be collected, time of year to collect the plant and quantities of plants to be collected per year area.

In this way, alternatives for the cultivation of Barbatimão are necessary and of great importance.

Besides the great importance of Barbatimão in the pharmaceutical area, it is also indicated for the recovery of degraded areas and can be used for the extraction of wood, which is heavy, hard and resistant to the action of climatic inclement weather (LORENZI, 1992).

Another factor that hampers the production of barbatimão for its intensive commercial exploitation is the lack of seedlings for planting. Since the species propagates in a seminiferous way in nature, subject to edafoclimatic intempéries. The plant's nutrition is still unknown, a fact that would facilitate the use of fertilizers for its production, which also increases the process of seedling production.

The search for more sustainable agricultural practices has brought the tendency of reuse of effluents and biosolids from domestic exhaustion. This fact from the agronomic point of view is very beneficial for the agricultural crops, to promote greater organic matter input, slow and continuous release of nutrients, improvement of soil microbiological conditions, etc. The reuse of water in irrigation in Brazil is no longer an alternative and is becoming a necessity, due to the low rainfall levels

observed in recent years and also that this type of effluent has been affecting the environment through the pollution of rivers (Queiroz et al. .

However, ANVISA regulates maximum levels for concentration of heavy metals in food, which can become contaminated with this form of fertilization. As barbatimão is not ingested by most humans in products that use its by-products, this concern is diminished.

Considering the above, it is hypothesized that the use of domestic effluent can significantly improve the growth of barbatimão seedlings, accelerating its growth in comparison to plants not fertilized with this effluent. Therefore, the objective of this work was to evaluate the growth of barbatimão seedlings as a function of increasing doses of domestic sewage effluent.

II. MATERIAL AND METHOD

The experiment was carried out in the city of Campo Grande-Mato Grosso do Sul, Brazil, and defined by the geographical coordinates "20º 23 '12" south latitude, "54º 36' 32" west longitude and 632 meters high.

The seeds were purchased via internet from a collector in the state of Santa Catarina - Brazil. The seeds were mechanically scarified by means of grooves, caused by the abrasion of a thick sandpaper in the seed coat. This practice was carried out in order to favor the entry of water into the seed and thus accelerate its germination process.

After the chiseling, two seeds per cell were planted with a volume of 280 cm3 filled with substrate with a coat of pinus with a volume of 280 cm3, without the use of mineral fertilization. Germination occurred approximately 35 days after sowing with germination rate of 65%. The initial irrigation of the trays was done by drinking water until the seedlings reached an average of 15 cm in height. At this moment the seedlings were transplants to plastic bags with volume of 7.5 liters, where they were cultivated until the end of the experiment.

The experimental design was a randomized block design, with five treatments and six replicates. The treatments consisted of increasing doses of domestic sewage effluent at doses (0%, 25%, 50%, 75% and 100%) consisting of dilutions of the diluted raw sewage in increasing proportions until complete irrigation by water without effluents. Each time the plants were irrigated 1.2 liters of the concentrations were applied. The pH of the soil on which the plants were cultivated was monitored periodically in order to avoid large oscillations. This fact would reduce the absorption of nutrients by the seedlings.

The biometric evaluations were initiated 30 days after transplanting when the plants were already established in the new container and consisted of: height of the plants (measured by means of millimeter ruler) being considered with initial point the region of the collection until the apex of the seedling; diameter of the stem (measured by means of digital caliper) and number of leaves counted from the base to the apex of the plant, being considered as leaf the petiole of the composite leaf inserted in the branches of the plant.

After 180 days of cultivation, the seedlings were sectioned and the following evaluations were carried out: wet weight of shoot, dry weight of shoot, root volume, root length, root weight, root dry weight. The plant materials were dried in a forced circulation oven for two days at a temperature of 70 ºC and afterwards weighed. The Dikson molt quality index (DICKSON et al., 1960) was also calculated by equation 1- Dickson Quality Index (DQI):

$$DQI = \frac{TDM\ (g)}{\frac{H\ (cm)}{D\ (mm)} + \frac{DSM\ (g)}{RDM\ (g)}} \quad (1)$$

This Dickson Quality Index (DQI) was determined as a function of total dry mass (TDM), height (H), diameter (D), dry shoot mass (DSM) and root dry mass (RDM).

At the end of the data collection, the analysis of variance and the averages of the treatments were performed using the Tukey test with significance level p> 0.05 and for the quantitative data performed the regression analysis.

III. RESULT AND DISCUSSION

Plant height was higher when water without effluent dilution was used, the diameter of the stem of the plants was higher when only drinking water was used (Table 1). The height evaluation of the shoot can be used to express the quality of the seedlings and is recognized as a good measure of the performance potential of the production. In the experiment, the height

was highlighted in the treatments with 0% and 100% of sewage, as shown in Fig 1.

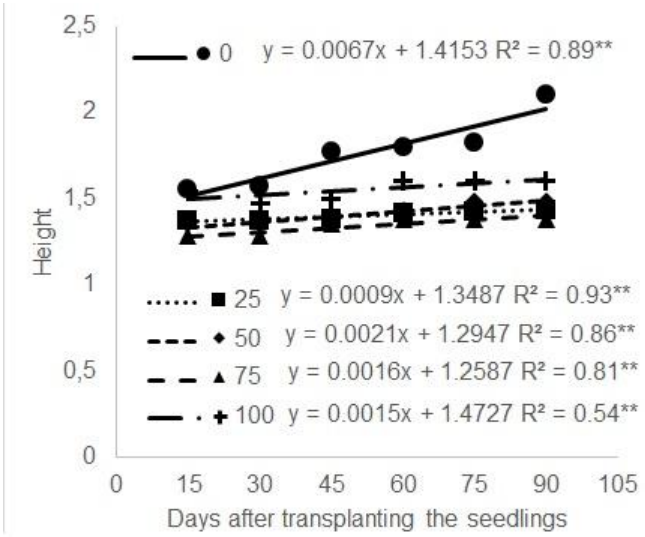

FIGURE 1 - Height of barbatimão seedlings as a function of increasing doses of domestic sewage effluent.

TABLE 1
DIAMETER, NUMBER OF LEAVES AND HEIGHT OF BARBATIMÃO PLANTS GROWN IN DIFFERENT CONCENTRATIONS OF DOMESTIC SEWAGE EFFLUENT.

Efluent (%)	Diâmeter (mm)	Number of leaves	Height (cm)
0	1.77 a	5.03 a	6.43 a
25	1.40 b	3.86 b	5.63 b
50	1.41 b	3.64 b	5.51 b
75	1.35 c	3.31 b	5.55 b
100	1.55 ab	4.14 ab	6.00 ab

TABLE 2
DRY AND WET WEIGHT, VOLUME AND LENGTH OF BARBATIMÃO VEGETATIVE MATERIAL, GROWN AT DIFFERENT CONCENTRATIONS OF DOMESTIC SEWAGE EFFLUENT.

Efluent (%)	HSW (g)	SDW (g)	RV (ml)	RL (cm)	MRW (g)	RDW (g)
	----------g----------		Ml	cm	----------g----------	
0	0.80 a	0.45 a	0.75 a	23.67 a	0.44 a	0.24 a
25	0.25 b	0.14 b	0.20 b	16.58 b	0.16 b	0.10 b
50	0.55 b	0.28 b	0.37 b	17.84 b	0.34 b	0.16 b
75	0.34 b	0.17 b	0.20 b	14.54 b	0.19 b	0.10 b
100	0.56 b	0.27 b	0.47 b	14.67 b	0.36 b	0.18 b

HSW - humid shoot weight; SDW - shoot dry weight; RV - root volume; RL – root length - MRW-moist root weight; RDW - root dry weight

The photosynthetic process occurs mainly in leaves. They convert solar (luminous) energy into a usable chemical form, producing carbohydrates from CO_2 and H_2O. In addition, they perform perspiration, accumulate and redistribute nutrients. Thus, the individuals with the highest number of leaves have greater availability of assimilated photos and, consequently, they present greater growth.

In general, the increase in the number of leaves was higher when only water 0% and sequentially 100% of sewage were used, as shown in Fig 2, following the same results represented by the treatments in height.

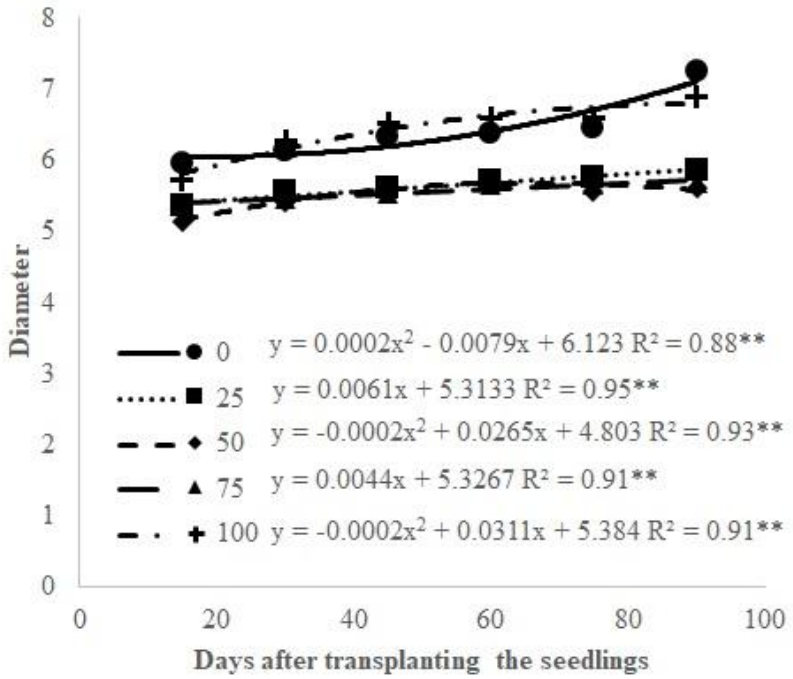

FIGURE 2 - Number of leaves of barbatimão seedlings as a function of the increasing doses of domestic sewage effluent.

The diameter of the lap is used to evaluate the survival capacity of seedlings and may also be indicated to help determine the fertilizer doses to be applied in the production of seedlings. In the present experiment, the results showed that the increase of effluent levels in the treatments did not allow a significant increase in stem diameter when compared to the use of only water, as shown by Fig 3.

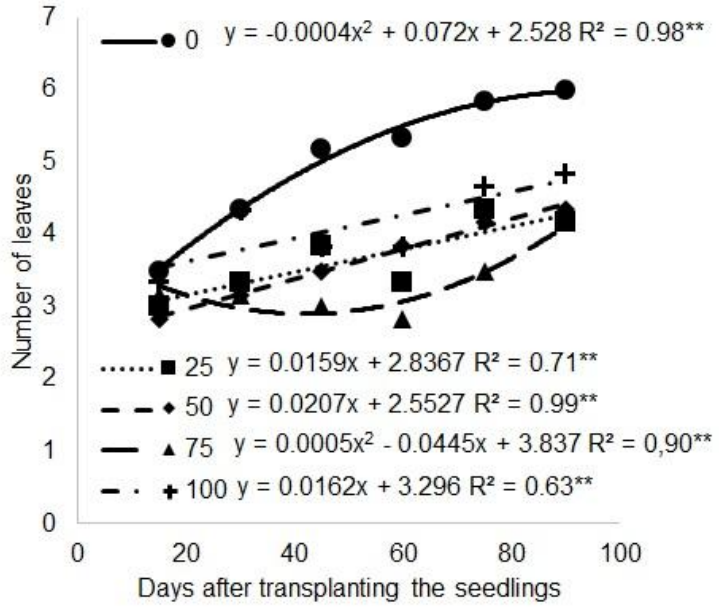

FIGURE 3 - Stem diameter of barbatimão seedlings as a function of increasing doses of domestic sewage effluent

In relation to the variables evaluated above, we observed that all the evaluated items did not diverge among themselves, with the exception of the root volume, showing a greater development when irrigated with only water (0% treatment).

With these results the Dickson quality index (IQD) was applied, which is recognized as a good quality indicator of seedlings, because the robustness (H / DC ratio) and the biomass distribution balance (MSPA ratio) / MSR) (TRAZZI, 2011), weighting

the results of several important morphological characteristics used for quality assessment. For Caldeira et al. (2012), the higher the IQD, the better the quality of the seedling. According to Birchler et al. (1998) and Hunt (1990), the IQD value should be greater than 0.2, which was not observed among the means of this study. In this experiment, the highest mean was obtained in the treatment with 0% sewage, that is, IQD = 0.13 as Fig 4.

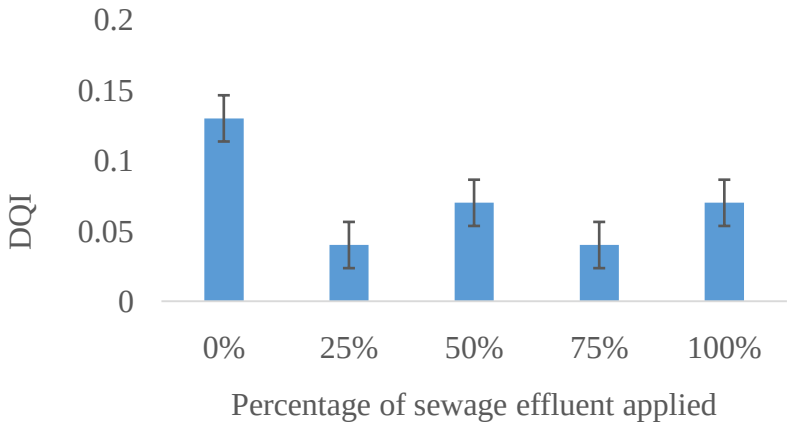

FIGURE 4 - Mean values and standard deviation for the Dicksom Quality Index (IQD) of barbatimão seedlings, as a function of the increasing doses of domestic sewage effluent.

However, several studies have demonstrated that IQD is a variable attribute, occurring differences depending on the species, the management, the type of substrate, the volume of the container and the age at which the seedlings were evaluated (Caldeira et al., 2005; TRAZZI, 2011).

The results indicate that the elevation of sewage levels in the substrate negatively influenced barbatimão seedlings. This fact was described by other authors who used this residue as a component of the substrate. Figueiró et al. (2005) observed a decrease in the emergence rate of melon seedlings grown on substrates containing sewage in proportions greater than 2.5%.

The use of sewage indicated that concentrations of this compound may be cytotoxic to the species. Thus, substrates with dosages of sewage sludge are not recommended for the production of barbatimão seedlings. These results coincide with those of Trigueiro and Guerriine (2003) and Morais et al. (1997), which found that composite substrates with sewage rates higher than 70% and 30% interfered negatively in the development of eucalyptus and cedar seedlings, respectively.

In general, the plants from the treatments with addition of sewage showed signs of intoxication such as necking and necrosis. This may have occurred because the substrate presents a higher concentration of organic matter and nutrients (GOMES et al., 2013). Another symptom observed in the barbatimão seedlings, cultivated in substrates with doses of sewage, is chlorosis, followed by necrosis at the tips of the leaves. Another observed symptom can be attributed to excess Zn, which in plants are characterized by reduced growth and leaf chlorosis (FONTES; COX, 1998). However, it was not possible to associate the symptoms of toxicity with a specific element because the nutritional requirements and the behavior of micronutrients in the development of this species still need to be further studied.

IV. CONCLUSION

In general, it was concluded that barbatimão seedlings were negatively influenced by the addition of domestic effluent from household wastewater. However, studies with lower dosages than those tested in this study are suggested.

V. AUTHORS RECOMMENDATION

O barbatimão é uma especie vegetal tradicional do cerrado brasileiro. A casca do barbatimão é muito utilizada na produção de medicamentos e cosméticos. Por ser uma planta de exploração extrativista, a atividade pode ser considerada agresssiva para as plantas que apos terem suas cascas tiradas podem morrer.Outro ponto a ser considerado é a falta de um protocol de adubação. Visando melhorar a nutrição de mudas de barbatimão em por meio do uso de effluent de esgotamento domestico.Este trabalho teve como objetivo estudar a produção de mudas de barbatimão em função de doses crescents de esgotamento domestic. O experiment foi conduzido em delinemanto de blocos ao acaso com 5 tratmentos e 10 repetiçoes . As mudas foram cultivadas em sacos plasticos de 7,5 litros preenchidos com substrates a base de casca de pinus. The

biometric evaluations were initiated 30 days after transplanting when the plants were already established in the new container and consisted of: height of the plants (measured by means of millimeter ruler) being considered with initial point the region of the collection until the apex of the seedling; diameter of the stem (measured by means of digital caliper) and number of leaves counted from the base to the apex of the plant, being considered as leaf the petiole of the composite leaf inserted in the branches of the plant. In general, it was concluded that barbatimão seedlings were negatively influenced by the addition of domestic effluent from household wastewater. However, studies with lower dosages than those tested in this study are suggested.

ACKNOWLEDGEMENTS

The authors thank the cosmetic Ana Mattos company for its support in the acquisition of barbatimão seeds.

REFERENCES

[1] ALMEIDA, N. F.; MORI, F. A.; GOULART, S. L; MENDES, L. M. Estudo da reatividade de taninos de folhas e cascas de barbatimão Stryphnodendron adstringens (Mart.).2010.

[2] ARDISSON, L; GODOY, J. S; FERREIRA, L. A. M; STEHMANN, J. R; BRANDÃO, M. G. L.; Preparação e caracterização de extratos glicólicos enriquecidos em taninos a partir das cascas de Stryphnodendron adstringens (Mart.) Coville (Barbatimão). Revista Brasileira de Farmacognosia. P. 27-34. 2002.

[3] BORGES FILHO, H. C.; FELFILI, J. M. Avaliação dos níveis de extrativismo da casca de barbatimão (Stryphnodendron adstringens (Mart.) Coville) no Distrito Federal, Brasil. Revista Árvore, Viçosa, v.27, n. 5, p. 735 - 745, 2003.

[4] BORLAUG, N.E. Feeding a world of 10 billion people: the miracle ahead. In: R. Bailey. Global warming and other eco-myths. Competitive Enterprise Institute, Roseville, EUA. p. 29-60 2002.

[5] KLINK, C. A.; MOREIRA, A. G. Past and current humanoccupation and land-use. In: P.S. Oliveira & R.J. Marquis (eds.).The Cerrado of Brazil. Ecology and natural history of aneotropical savanna. pp. 69-88. Columbia University Press,New York, 2002.

[6] LAMAIRE, F. Physical, chemical and biological properties of growing medium. Acta Horticulturae, Leuven, v. 396, p. 273-284, 1995.

[7] MACHADO, R. B.; RAMOS NETO, M. B.; PEREIRA, P.; CALDAS, E.; GONÇALVES, D.; SANTOS, N.; TABOR, K.; STEININGER, M. Estimativas de perda da área do Cerrado brasileiro. Conservation International do Brasil, Brasília, 2004.

[8] METCALF, B.; EDDY, I. N. C. Wastewater Engineering: treatment, disposal and Reuse. 3. Edd. New York: McGraw-Hill, 1991.

[9] OCCHIONI, E. M. L. Considerações taxonômicas no gênero Stryphnodendron Mart. (Leguminosae-Mimosoideae) e distribuição geográfica das espécies. Acta Botânica Brasilica, Porto Alegre, v. 4, n. 2, p. 153-158, 1990.

[10] SALOMÃO, A. N.; SILVA, J. C. S.; DAVIDE, A. C.; GONZALES, S.; TORRES, R. A. A.; WETZEL, M. M. V. S.; FIRETTI, F.; CALDAS, L. S. Germinação de sementes e produção de mudas de plantas do cerrado. Brasília: Rede de Sementes do Cerrrado, 2003. 96 p.

[11] SOUSA, J. T.; HAANDEL, A.V; GUIMARÃES, A.V.A . Performance of constructed wetland systems treating anaerobic effluents. Water Science and Technology, v.48, n.6, p. 295-299, 2003.

[12] SOUSA, J. T.; LEITE, V. D. Tratamento e utilização de esgotos domésticos na agricultura. Campina Grande: EDUEP, 2003. 135p.

[13] PANIZZA, S.; ROCHA, A. V.; GECCHI, R.; SOUZA E SILVA, R. A. P. Stryphnodendron barbadetiman (Vellozo) Martius: Teor em tanino na casca e sua propriedade cicatrizante. Revista Ciências Farmacêuticas, São Paulo, v. 10, p. 101-106, 1988.

[14] ALMEIDA, S. P.; PRONEÇA, C. E. B.; SANO, S. M.; RIBEIRO, J. F. Cerrado: espécies vegetais úteis. Planaltina: Embrapa CPAC, 464 p, 1998.