(DOI): 10.5935/PAeT.V10.N2.12

Brazilian Journal of Applied Technology for Agricultural Science, Guarapuava-PR, v.10, n.2 p.111-117, 2017

Technical Note

Indolbutiric acid responses on rooting and survival of *Hymenaea courbaril* L. cuttings

Daniel Pena Pereira[1]
Édimo Fernandes Alves Moreira[2]
Emerson Ribeiro Machado[3]
Thayná Soares Mariano[4]
Fernando Rodrigues da Cunha [4]

Abstract

Currently, the environmental appeal to promote reforestation programs, recovery of degraded areas and preservation of biodiversity pressures the production sector of native forest essences' seedlings. Jatoba, *Hymenaea courbaril* L., is a native tree which provides many products of great economic relevance. Vegetative propagation is an alternative method for seedlings production, which presents many benefits, including the possibility of establishing high productivity clonal hedges, as it occurs with the *Eucalyptus* genus. The experiment was conducted in a greenhouse, with partial temperature and humidity control. The study assessed the effects of different dosages of indolbutiric acid (IBA) hormone in the process of rooting jatoba cuttings. The cuttings were prepared in a laboratory and submitted to different dosages of IBA (0, 200, 400, 600, 800 e 1000 mg L^{-1}), later established in sand substrate and placed in protected environment with intermittent fogging system and shading of 50%. Statistical analysis was carried out using R software, according to experimental design in randomized blocks, with six treatments and four replications. The results obtained by binomial evaluation showed there was no significant difference between IBA dosages, so the use of IBA on rooting H. *courbaril* cuttings was ineffective. However, success in the vegetative propagation of *jatoba* can occur through the selection of individuals that present good results to adventitious rooting. The use of IBA on adventitious rooting varies from one species to another, and due to the lack of studies on the subject concerning *Hymenaea courbaril* L., more experiments to be carried out in order to evaluate the rhizogenic potential should be done.

Key words: Adventitious rooting, biodiversity, IBA, jatoba.

Resumo

Respostas de ácido indolbutírico sobre enraizamento e sobrevivência de estacas de *Hymenaea courbaril* L.

Atualmente, o apelo ambiental para promover programas de reflorestamento, recuperação de áreas degradadas e preservação da biodiversidade pressiona o setor de produção de mudas de essências florestas nativas. Jatoba, *Hymenaea courbaril* L., é uma árvore nativa que fornece muitos produtos de grande relevância econômica. A propagação vegetativa é um método alternativo para a produção de mudas, que apresenta muitos benefícios, incluindo a possibilidade de estabelecer sebes clonais de alta produtividade, pois ocorre com o gênero *Eucalyptus*. O experimento foi realizado em uma estufa, com controle parcial de temperatura e umidade. O estudo avaliou os efeitos de diferentes dosagens de hormônio do ácido indolbutirico (IBA) no processo de enraizamento de estacas de jatoba. As estacas foram preparadas em laboratório e submetidas a diferentes dosagens de IBA (0, 200, 400, 600, 800 e 1000 mg L^{-1}), posteriormente estabelecidas em substrato de areia e colocadas em ambiente protegido com sistema de nebulização intermitente e sombreamento de 50 %. A análise estatística foi realizada utilizando o software R, de acordo com o desenho experimental em blocos ao acaso, com seis tratamentos e quatro repetições. Os resultados obtidos pela avaliação binomial

Received at: 18/12/16 Accepted for publication at: 07/06/17

[1] PhD. Prof. Agronomy department. Instituto Federal do Triângulo Mineiro - IFTM, campus Uberaba, Uberaba-MG, Brazil. Rua João Batista Ribeiro, 4000 – Distrito Industrial II. CEP 38064-790. Uberaba-MG, Brazil. Email: danielpena@iftm.edu.br

[2] MSc. Prof. Agronomy department. Instituto Federal do Triângulo Mineiro, campus Uberaba, Uberaba-MG, Brazil. Email: edimo@iftm.edu.br

[3] Biologist and environmental researcher. MGO Rodovias – Uberlândia-MG, Brazil. Email: emachado@mgorodovias.com.br

[4] Agronomy college. Instituto Federal de Educação, Ciência e Tecnologia do Triangulo Mineiro – campus Uberaba, Uberaba-MG, Brazil. Email: tha.smariano@gmail.com; fernandorodriguesdacunha@hotmail.com

mostraram que não houve diferença significativa entre as dosagens IBA, então o uso de IBA nas estacas de H. *courbaril* rooting foi ineficaz. No entanto, o sucesso na propagação vegetativa de jatoba pode ocorrer através da seleção de indivíduos que apresentam bons resultados ao enraizamento acidental. O uso de IBA em enraizamentos acidentais varia de uma espécie para outra e, devido à falta de estudos sobre o assunto em relação a *Hymenaea courbaril* L., devem ser realizados mais experimentos a serem realizados para avaliar o potencial rizogênico.

Palavras chave: Enraizamento adventicioso, biodiversidade, IBA, jatoba.

Resumen

Respuestas de ácido indolbutirico sobre enraizamiento y supervivencia de estacas de *Hymenaea courbaril* L.

Actualmente, el llamamiento ambiental para promover programas de reforestación, recuperación de áreas degradadas y preservación de la biodiversidad presiona el sector de producción de mudas de esencias forestales nativas. Jatoba, *Hymenaea courbaril* L., es un árbol nativo que proporciona muchos productos de gran relevancia económica. La propagación vegetativa es un método alternativo para la producción de mudas, que presenta muchos beneficios, incluyendo la posibilidad de establecer clones de alta productividad, así como ocurre con el género *Eucalyptus.* El experimento fue realizado en un invernadero, con control parcial de temperatura y humedad. El estudio evaluó los efectos de diferentes dosis del ácido indolbutiric (IBA) en el proceso de enraizamiento de estacas de Jatobá. Las estacas fueron preparadas en laboratorio y sometidas a diferentes dosis de IBA (0, 200, 400, 600, 800, 1000 y 1000 mg L^{-1}), posteriormente establecidas en sustrato de arena y colocadas en un ambiente protegido con sistema de nebulización intermitente y sombreado 50%. El análisis estadístico se realizó utilizando el software R, de acuerdo con el diseño experimental en bloques al azar, con seis tratamientos y cuatro repeticiones. Los resultados obtenidos por la evaluación binomial mostraron que no hubo diferencia significativa entre las dosis de IBA, entonces el uso de IBA en las estacas de H. courbaril fue ineficaz. Sin embargo, el éxito en la propagación vegetativa del Jatobá puede ocurrir a través de la selección de individuos que presentan buenos resultados al enraizamiento adventicio El uso de IBA en enraizamientos adventicio varía de una especie a otra y, debido a la falta de estudios sobre el tema en relación a *Hymenaea courbaril* L., se deben realizar más experimentos para evaluar el potencial rizogénico.

Palabras clave: Enraizamiento adventicioso, biodiversidad, IBA, jatoba.

Introduction

The species *Hymenaea courbaril* L. is a decidious tree, found throughout phytogeographical domains of the Amazon, Caatinga, Cerrado, Mata Atlantica and Pantanal, popularly known as jatoba (LIMA and PINTO, 2016). The word *Hymenaea* comes from “hymen”, which means “god of unions”, in allusion to the two paired leaflets (or foliole) in leaves, a feature present in plants of this genre (Figure 1); its flowers are hermaphrodites and pollination occurs by bats (SILVA et al., 2014) and moths. The flowering period is from October to March, and fruiting occurs from July to September (ALMEIDA et al., 1998).

Figure 1. H. *courbaril* features (Source: LIMA and PINTO, 2016).

The jatoba tree is of large dimensions, sometimes reaching 30m high. It provides high durability wood, and can be used in construction and in the making of canoes. Jatoba fruits edible, and are very appreciated by rural populations in its raw form, or even in porridges (ALMEIDA et al., 1998; LORENZI, 1998). As for the stem resin, known as jutai-cica, it is widely used as a tonic and expectorant, and its main function is the cure for bronchitis and it is also widely used as vermifuge; its peel is used against cystitis and prostatitis (FERREIRA, 1980; BARROS, 1982; SIQUEIRA, 1988; GAVILANTES and BRANDÃO, 1992; ALMEIDA et al., 1998). Most of Jatoba studies are shown at Table 1.

Table 1. Review on related studies with *Hymanae courbaril* L.

Research area	Parts studied	References
Seedling production	Stem cutting	Carvalho Filho et al., (2003).
Antimicrobial properties	Plants extracts	Fernandes et al., (2005)
Seed dispersal	Seeds	Asquith et al., (1999)
Anatomical features and growth	Wood	Luchi (1998)
Seedlings growth	Seeds	Nascimento et al., (2011)
Seed dispersal	Seeds	Hallwachs (1986)
Seed dormancy	Seeds	Oliveira et al., (1995)
Seedling growth	Seedlings	Vicente Ferraz and Angel (2011)
Chemical compounds	Cotyledons	Buckeridge et al., (1997)
Chemical compounds	Leaf pocket resin	Martin et al., (1972)
Chemical compounds	Leaves	Busato et al., (2001)
Chemical compounds	Seed oil	Dias et al., (2013)
Chemical compounds	Seeds	Arruda et al., (2015)

The increasing demand for forest recovery projects and preservation of biodiversity due to deforestation, indiscriminate fires and illegal logging has boosted research on the production of seedlings of native forest species. The species *H. courbaril* occurs in low population densities with less than one tree per hectare (SILVA et al., 2014), but presents a wide distribution, indicating a probable tolerance and adaptation to the varied range of environments (OLIVEIRA, et al., 2011). The propagation of *H. courbaril* occurs mainly through seeds (CARVALHO, 2007), and there are few studies concerning vegetative propagation. Vegetative propagation of forest species present several benefits, such as the establishment of high productivity clonal hedges, improvement of wood quality and its derived products, multiplication of individuals adapted to specific sites and resistant to pests and diseases (WENDLING and XAVIER, 2005).

Jatoba is largely used for purposes of environmental recovery and restoration, being the species, according to Silva Junior et al. (2001) listed among the 25 priority ones for programs of recovery of degraded forest areas. Because of that, there is a great demand for the production of quality seedlings, which requires a propagation method less time consuming than through seeds, already in use. Despite the knowledge on other economically interesting forest species, there are some reservations about vegetative propagation methods of the jatoba. This paper aims to verify the effects of IBA hormone dosages concerning the survival probability of *H. courbaril* L. cuttings.

Materials and methods

Data used in this study were obtained from an experiment carried out in a greenhouse with partial control of temperature and humidity, located at the Experimental Horticulture Area at Instituto Federal de Educação, Ciência e Tecnologia do Triângulo Mineiro (IFTM), in the municipality of Uberaba, state of Minas Gerais. The researchers used experimental design in randomized blocks with six quantitative treatments of indolbutiric acid (IBA), at dosages of 0, 200, 400, 600, 800 e 1000 mg L^{-1}, and four replications. The experimental unit consisted of nine jatoba cuttings. Cuttings were obtained of seedling, produced with seeds by Instituto Estadual de Florestas (IEF) in Uberaba, Minas Gerais, southeastern Brazil. From each seedling one semi-hardwood stem cutting was taken, with three or more gems and an average size of 13.24cm. In order to reduce the area of transpiration and ensuing dehydration, we trimmed 50% of the leaf area in each cutting.

The treatments, dosages of 0, 200, 400, 600, 800 e 1000 mg L^{-1}, were obtained through the dilution of indolbutiric acid in 250ml of distilled water until the desired concentration. Cuttings were immersed in this solution, remaining there for 10 minutes.

In order to measure the effects of IBA dosages we evaluated the cuttings' survival probability. For this, we considered 9 cuttings, which presented stem gems in sprouting or were green. This evaluation occurred 60 days after the treatments were executed.

To verify the effects of IBA in the survival probability of jatoba cuttings, data were submitted to a deviance analysis. It is worth mentioning that this analysis is used when a generalized linear model is adjusted; we further highlight that in such analysis it was possible to directly model the response variable, by means of its probability distribution.

In the adjusted generalized model a binomial distribution was utilized, which is the distribution of the survival percentage variable, and the connection function used was logarithmic. In the analysis, the probability level of 5% was used. All analysis were performed in the R software (R Core Team, 2015).

Results and discussion

Deviance analysis shows that IBA dosages have no significant effect on the survival probability of jatoba cuttings (p-value > 0.05) (Table 2).

Table 2. Deviance analysis of a generalized model with binomial distribution for jatoba cuttings' survival probability according to IBA dosages.

	Gl	Deviance	Gl residue	Residual Deviance	p-value
Null Model			23	29.367	
Dosages	1	0.058124	22	29.308	0.8095

The model adjusted for survival probability according to IBA dosages is shown on Figure 2. It is observed there is no effect from IBA dosages; therefore, the survival probability is constant, equal to 0.435182.

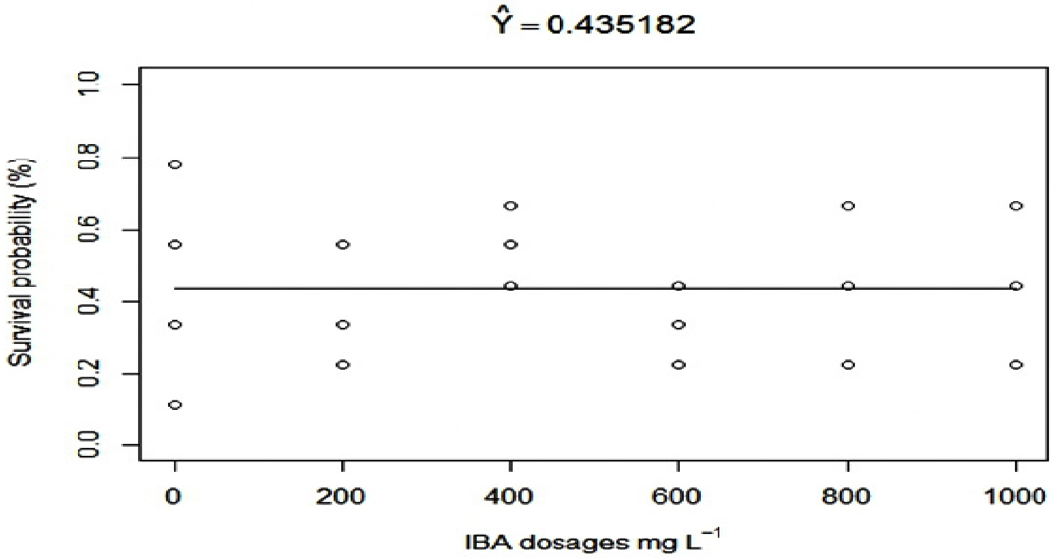

Figure 2. Model adjusted for the survival probability of jatoba cuttings according to IBA dosages.

Vieira et al. (2012) observed that the highest survival percentage rates for *H. stignocarpa* were seen when IBA had not been added and occurred when cuttings were removed from the base to the middle. Generally, this species has shown difficulties in surviving after cutting, as well as rooting difficulties, unrelated the concentration of hormone used. The results achieved by these authors support the evidence found in the present study.

Although the survival probability is a constant value, as shown in Figure 2, one can observe the response variability among the observations for equal dosages. At dosage dose 0 mg L^{-1} (control dosage), one point reaches a survival probability of almost 80%. At dosages of 400, 600 and 1000 mg L^{-1}, probability rates reach approximately 70%. This indicates a genetic variation of the used cuttings. It is worth highlighting there may be success the vegetative propagation of jatoba, picking out individuals with a good response to adventitious rooting.

In general, some studies demonstrate other variables which affect adventitious rooting with the application of exogenous auxins, such as: substrate (MENDES et al., 2014; COSTA et al., 2015; HUSSAIN et al., 2014; CARDOSO et al., 2011; PELIZZA et al., 2011), methods of application of plant regulators (PEÑA et al., 2012), the time of collection of propagating material (PIVETTA et al., 2012; LIMA et al., 2011b; PIZZATTO et al., 2011) and anatomical features of vegetable tissues (LIMA et al., 2011a).

IBA also varies from one species to another. Vernier and Cardoso (2013) verified that the use of indolbutiric acid (IBA) had a positive influence on rooting cuttings of *Malpighia glabra* L., with a greater rooting potential of cuttings than the witness. The use of IBA had no influence in the percentage of rooted cuttings, but provided more vigorous seedlings in less time, showing to be effective in the increase and speed of the roots' emission.

According to Chagas et al. (2008) the highest rooting percentage for *Prunus mume sieb* e *Zucc* was at a concentration of 1000 mg L^{-1} of IBA. As for the propagation by herbaceous cuttings of *Prunus sp*, some authors quoted by Chagas et al. (2008) achieved rooting when cuttings were treated with IBA at approximately 2000 mg L^{-1}.

Almeida et al. (2007) showed that minicutting is a viable technique for vegetative propagation of *Eucalyptus cloeziana* clones, with overall high rooting rates. Clones with higher adventitious rooting potential gave better response to lower IBA doses, while clones with reduced rooting potential were more efficient with higher doses, independently of the form of the applied phytoregulator (powder or liquid).

When comparing the results presented by the author to those found in literature, one can infer that IBA efficiency is varies according to the species in case, as well as optimum dosage. However, there are scarce results from experiments in literature addressing IBA x *Hymenaea sp*. Therefore, new experiments must be performed to investigate the actual efficiency of IBA hormone on the rhizogenic potential of *Hymenaea courbaril* L. cuttings.

Conclusion

Even though IBA dosages used were not statistically significant, proving ineffective to induce adventitious rooting of H. *courbaril*, the species presented survival difficulties on rooting after cutting. However, it has been observed that some experimental units showed a high probability of survival rate, probably attributed to genetic factors. So, the results indicate variability of response between the observations for the same dose, and it may be successful in the vegetative propagation of the *jatoba* through the selection of individuals that present good results to the adventitious rooting.

Due to scarce studies available on the use of IBA for H. *courbaril* rooting, we encourage more experiments to be carried out in order clear questions concerning environmental conditions, exogenous auxins and further inherent characteristics to the vegetative propagation of jatoba. And this is important because of the importance of the species for the recovery of degraded forest areas and diversified popular use.

References

ALMEIDA, F. D.; XAVIER, A.; DIAS, J. M. M.; PAIVA, H. N. Eficiência das auxinas (AIB e ANA) no enraizamento de miniestacas de clones de *Eucalyptus cloeziana* F. Muell. **Revista Árvore**, v.31, n.3, p.455-463, 2007.

ALMEIDA, S. P.; PROENÇA, C. E. B.; SANO, S. M.; RIBEIRO, J.F. **Cerrado: espécies vegetais úteis**. Planaltina: EMBRAPA – CPAC, 1998.

ARRUDA, I. R. S.; ALBUQUERQUE, P. B. S.; SANTOS, G. R. C.; SILVA, A. G.; MOURÃO, P. A. S.; CORREIA, M. T. S.; VICENTE, A. A.; CARNEIRO-DA-CUNHA, M. G. Structure and rheological properties of a xyloglucan extracted from *Hymenaea courbaril* var. courbaril seeds. **International Journal of Biological Macromolecules**, v.75, p.31-38, 2005.

ASQUITH, N. M.; TERBORGH, J.; ARNOLD, A. E.; RIVEROS, C. M. The fruits the agouti ate: *Hymenaea courbaril* seed fate when its disperser is absent. **Journal of Tropical Ecology**, v.15, n.2, p.229-235, 1999.

BARROS, M. A. G. Flora medicinal do Distrito Federal. **Brasil Florestal**, v.50, n.12, p.35-45. Planaltina: EMBRAPA – CPAC, 1982.

BUCKERIDGE, M. S.; CROMBIE, H. J.; MENDES, C. J. M.; REID, J. S. G.; GIDLEY, M. J.; VIEIRA, C. C. J. A new family of oligosaccharides from the xyloglucan of *Hymenaea courbaril* L.(*Leguminosae*) cotyledons. **Carbohydrate** research, v.303, n.2, p.233-237, 1997.

BUSATO, A. P.; VARGAS-RECHIA, C. G.; REICHER, F. Xyloglucan from the leaves of *Hymenaea courbaril*. **Phytochemistry**, v.11, n.10, p.3049-3051, 2001.

CARVALHO, P. E. R. **Jatobá-do-cerrado: Hymenaea stignocarpa.** Colombo, PR: Embrapa Florestas, 2007.

CARVALHO FILHO, J. L. S. D.; ARRIGONI-BLANK, M. D. F.; BLANK, A. F.; RANGEL, M. S. A. Produção de mudas de jatobá (*Hymenaea courbaril* L.) em diferentes ambientes, recipientes e composições de substratos. **Cerne**, v.9, n.1, p.109-118, 2003.

CHAGAS E. A.; PIO, R.; BETTIOL NETO, J. E.; SOBIERAJSKI, G. R.; DALL´ORTO, F. A. C.; SIGNORINI, G. Enraizamento de estacas lenhosas de pessegueiro e clones de umezeiros submetidos à aplicação de AIB, **Ciência e Agrotecnologia**, v.32, n.3, p.986-991, 2008.

DIAS, L. S.; LUZIA, D. M. M.; JORGE, N. Physicochemical and bioactive properties of *Hymenaea courbaril* L. pulp and seed lipid fraction. **Industrial Crops and Products**, v.49, p.610-618, 2013.

FERNANDES, T. T.; SANTOS, A. T. F. D.; PIMENTA, F. C. Atividade antimicrobiana das plantas *Plathymenia reticulata, Hymenaea courbaril* e *Guazuma ulmifolia*. **Revista de Patologia Tropical**, v.34, n.2, p.113-122, 2005.

FERREIRA, M. B. Frutos comestíveis nativos do cerrado em Minas Gerais. **Informe Agropecuário**, v.61, n.6, p.9-18. Belo Horizonte: EPAMIG, 1980.

GAVILANTES, M. L.; BRANDÃO, M. Frutos, folhas e raízes de plantas do Cerrado, suas propriedades medicinais, tendo como veículo a cachaça. **Informe Agropecuário**, v.16, n.173, p.40-44. Belo Horizonte: EPAMIG, 1992.

HALLWACHS, W. Agoutis (*Dasyprocta punctata*): the inheritors of guapinol (*Hymenaea courbaril*: Leguminosae). In: Estrada, A.; Fleming, T.H. (Eds.). **Frugivores and seed dispersal**, Springer Netherlands, 1986. p.285-304.

LIMA, H. C.; PINTO, R. B. **Hymenaea in Lista de Espécies da Flora do Brasil**: Jardim Botânico do Rio de Janeiro, 2014. Available in: http://floradobrasil.jbrj.gov.br/reflora/floradobrasil/FB22972. Accessed: August 31, 2016.

LORENZI, H. **Árvores brasileiras: manual de identificação e cultivo de plantas arbóreas nativas do Brasil**. São Paulo: Editora Plantarum, 1998.

LUCHI, A. E. **Periodicidade de crescimento em *Hymenaea courbaril* L. e anatomia ecológica do lenho de espécies de mata ciliar**. 1998, 209f. (PhD thesis). Universidade de São Paulo, São Paulo, Brazil, 1998.

MARTIN, S. S.; Langenheim, J. H. Sesquiterpenes in leaf pocket resin of *Hymenaea courbaril*. **Phytochemistry**, v.11, n.10, p.3049-3051, 1972.

NASCIMENTO, H. H. C.; NOGUEIRA, R. J. M. C.; SILVA, E. C.; SILVA, M. A. Análise do crescimento de mudas de jatobá (*Hymenaea courbaril* L.) em diferentes níveis de água no solo. **Revista Árvore**, v.35, n.3, p.617-626, 2011.

OLIVEIRA, P. S.; GALETTI, M.; PEDRONI, F.; MORELLATO, L. P. C. Seed cleaning by Mycocepurus goeldii ants (Attini) facilitates germination in *Hymenaea courbaril* (Caesalpiniaceae). **Biotropica**, v.27, n.4, p.518-522, 1995.

OLIVEIRA, W. L.; MEDEIROS, M. B.; MOSER, P.; PINHEIRO, R.; OLSEN, L. B. Regeneração e estrutura populacional de jatobá-da-mata (*Hymenaea courbaril* L.), em dois fragmentos com diferentes graus de perturbação antrópica. **Acta Botanica Brasilica**, v.25, n.4, p.876-884, 2011.

R CORE TEAM. (**2015). R: A language and environment for statistical computing.** R Foundation for Statistical Computing. Available in: http://www.project.org. Accessed: June 4, 2016.

SILVA, S. M. M.; MARTINS, K.; MESQUITA, A. G. G.; WADT, L. H. O. Parâmetros genéticos para a conservação de *Hymenaea courbaril* L. na amazônia sul-ocidental. **Ciência Florestal**, v.24, n.1, p.87-95, 2014.

SILVA JUNIOR, M. C.; FELFILI, J. M.; WALTER, B. M. T.; NOGUEIRA, P. E.; REZENDE, A. V.; MORAIS, R. O.; NÓBREGA, M. G. G. Análise da flora arbórea de Matas de Galeria no Distrito Federal: 21 levantamentos. In: RIBEIRO, J. F.; FONSECA, C. E. L.; SOUSA SILVA J. C (Eds.). **Cerrado: caracterização e recuperação de matas de galeria**. Planaltina, Embrapa Cerrados, 2001. p.143-191.

SIQUEIRA, J. C. S. L. **Plantas medicinais: identificação e uso das espécies dos cerrados**. São Paulo: Edições Loyola, 1988.

VIEIRA, E. L.; OLIVEIRA, C. S.; GONÇALVES, L. E. N.; VIEIRA, M. C.; OLIVEIRA JÚNIOR, R. J.; ARRUDA, A. S. **Efeitos do AIB no enraizamento de estacas via hidroponia de *Hymenaea stigonocarpa* Mart: Malinovski Florestal,** 2012. Available in: http://malinovski.com.br/CongressoFlorestal/Trabalhos/05-Silvicultura/SIL-Artigo-18.pdf. Accessed: October 9,2015.

VERNIER, R. M., e CARDOSO, S. M. (2013). Influência do ácido indol-butírico no enraizamento de estacas em espécies frutíferas e ornamentais. **Revista Eletrônica de Educação e Ciência**, 3 (2), 11-16. http://fira.edu.br/revista/vol3_num2_pag11.pdf. Accessed 9 Oct 2015.

WENDLING, I., e XAVIER, A. Influência do ácido indolbutírico e da miniestaquia seriada no enraizamento e vigor de miniestacas de clones de *Eucalyptus grandis*. **Revista Árvore**, v.29, n.6, p.921-930, 2005.