Indolbutyric acid on rooting of cuttings of mini rose bush [(1)]

KELLI PIROLA[(2)*]; MARCELO DOTTO[(2)]; DARCIELI APARECIDA CASSOL[(2)]; AMÉRICO WAGNER JÚNIOR[(3)] e IDEMIR CITADIN[(2)]

ABSTRACT

The roses are considered as the main cut flowers exported from Brazil and also the most popular in the domestic market. Usually, roses can be propagated by grafting or cutting. The aim of this study was to evaluate the cuttings' size and IBA concentration on mini-cutting rooting of roses variety Mary Rose. Cuttings were obtained from mother plants grown in gardens, with sizes of 3, 5 and 7 cm of length, 1.0 cm in diameter, and treated with IBA, in the concentrations of 0; 500 and 1000 mg L^{-1}. The experimental design was installed in randomized blocks, in a factorial 3 x 3 (mini-cutting sizes x IBA concentration), with 4 repetitions and 10 mini-cuttings per plot. After 60 days rooted cuttings (%), cuttings with callus (%), primary sprouting, leaves and roots numbers, length of the three major roots (cm) and mortality (%) were evaluated. It is recommended to propagate roses by the use of mini-cuttings with 7 cm treated with 500 mg L^{-1} of IBA.

Keywords: *Rosa* sp.,vegetative propagation, ornamental plant.

RESUMO

Ácido indolbutírico no enraizamento de mini estacas de roseira

A rosa constitui a principal flor de corte exportada pelo Brasil e também a mais procurada no mercado interno. Usualmente, a roseira pode ser propagada por meio da enxertia ou estaquia. O objetivo deste trabalho foi avaliar o tamanho de estacas e a concentração de AIB no enraizamento de mini estacas de roseira da variedade Mary Rose. As estacas foram coletadas de plantas matrizes cultivadas em jardins nos tamanhos 3, 5 e 7 cm de comprimento, com 1,0 cm de diâmetro, e tratadas com AIB, nas concentrações de 0; 500 e 1000 mg L^{-1}. O experimento foi instalado em delineamento em blocos ao acaso, em fatorial 3 x 3 (tamanho de mini estacas x concentração de AIB) com 4 repetições e 10 estacas por parcela. Após 60 dias, avaliaram-se as estacas enraizadas (%), estacas com calo (%), número de brotações primárias, número de raízes primárias, número de folhas, comprimento das três maiores raízes (cm) e estacas mortas (%). Recomenda-se a utilização de mini estacas com 7 cm, e tratamento com 500 mg L^{-1} de AIB para propagação de mini roseira.

Palavras-chave: *Rosa* sp.,propagação vegetativa, planta ornamental.

1. INTRODUCTION

The market for flowers and ornamental plants is one of the most competitive industry that is booming and moves millions of dollars around the world, with Netherlands being the largest exporter of flowers, followed by Colombia and Italy (LANDGRAF and PAIVA, 2009; Mota et al., 2007). Brazil still has small share of the world market, but has been increasing over the years (REGO et al., 2004).

In Brazil, the marketing and distribution of flowers and ornamental plants is done through marketing centers. The main flower market, where products come from suppliers and wholesalers is CEAGESP-SP and CEASA-Campinas (ARRUDA et al., 1996; CASTRO, 1998). However, the lack of classification standards and long period marketing impact the appearance of products, which is essential for marketing flowers. According to Arnaldi and Perosa (2007), the flower market is characterized by fierce competition, it is fundamental to present good productivity levels, standardization, quality, good presentation, appropriate packaging and varieties with good acceptance, to become competitive and get good prices on the market.

Despite the lack of participation of Brazil in the exportation of flowers, roses are on the main cut flowers exported from Brazil and also the most popular in the domestic market. From the year 2000, the State of Ceara began the protected cultivation of roses, occupying in 2007 the position of Brazilian main exporter (JUNQUEIRA and PEETZ, 2013).

The rose (*Rosa* sp.), belongs to the Rosaceae family, having about 200 wild species and more than 30 thousand varieties, which are derived from crosses and backcrossing. Many hybrid varieties make rosebushes, which arefrom temperate temperatures, adapted to the climatic conditions in Brazil (BARBOSA et al., 2005).

The propagations of roses can be sexual, using seeds or asexually, by cuttings, by grafting and micropropagation (BARBOSA et al., 2005). The asexual methods allow obtaining plants identical to the mother plant within a short time period to attain the age of production (DONADIO et al., 1992). As for grafting, it is necessary prior preparation of another genetic material requiring more time and financial resources. But the use of cuttings becomes promising, especially for the possibility of propagating a large number

[(1)]Recebido em 04/11/2013 e aceito em 02/03/2016

[(2)]Universidade Tecnológica Federal do Paraná, campus Pato Branco, Pato Branco-PR, Brazil. *Corresponding author: kelli_pirola1@hotmail.com.

[(3)] Universidade Tecnológica Federal do Paraná (UFTPR), campus Dois Vizinhos, Dois Vizinhos-PR, Brazil

of plants from a single mother plant in a short time; the low cost and easy implementation (FACHINELLO et al., 2005).

However, according to some producers, rose cuttings rooting has not reached satisfactory percentages of rooting and survival fora good commercial production (ONO et al., 2004).

Typically, for many species in the propagation by cuttings are used cuts with length of 12 to 15 cm as for hibiscus (PIZZATTO et al., 2011) and *Fuchsia sp.* (ALCANTARA et al., 2008), however, depending on the species, is not considered appropriate as there are promising work experiments testing shorter cuttings

Thus, for some species due to rooting difficulties, as for *Eucalyptus* in the propagation by cuttings, especially when it involves adult material, was developed the mini cutting technique (XAVIER and WENDLING, 1998; HIGASHI et al., 2000) allowing considerable gains, particularly for increasing rates and quality of rooting and reducing the time for the formation of saplings (BORGES et al., 2011).

However, to stimulate and accelerate the rooting of mini cuttings, standardizing and inducing the formation of roots is important to use plant growth regulators. Among the growth regulatory substances, auxins are those which have shown the greatest effect on the formation of adventitious roots (HARTMANN et al., 2002; FACHINELLO et al., 2005).

The main purpose of using exogenous IBA is to accelerate the cuttings rooting process, and the concentrations used vary according to the season, type of cutting and species to be propagated and there is a range of optimal values that is considered great on stimulating this process (WENDLING and XAVIER, 2005). Therefore, for it to be suitable for rooting of roses, one must first determine the optimal concentration of the regulator.

Thus, the aim of this study was to evaluate the size of cuttings and concentration of IBA (indolbutyric acid) on rooting of mini cuttings of roses.

2. MATERIAL AND METHODS

The mini cuttings were provide from mother plants of the variety Mary Rose, which are rosebushes with an older appearance and shrubby aspect, pronounced odor and flowers in the form of rosettes proper to old rosebushes. The mini cuttings were collected and placed in buckets with water, avoiding dehydration and oxidation, for subsequent withdrawal and implementation of the experiment. The sizes tested in mini cuttings were 3, 5 and 7 cm in length and approximately 1.0 cm diameter.

In all mini cuttings were two superficial lesions in the basal part, on opposite sides, removing a portion of the shell of about 0.5 cm wide by 1.0 cm long. The IBA concentrations tested were 0; 500 and 1000 mg L^{-1}. The applications of these IBA solutions were made by quick dipping (5 seconds) on the base of the mini cuttings (1.5 cm). In preparing the solution of IBA, the same was dissolved in KOH 5N and absolute ethylic alcohol, subsequently diluted in distilled water to the desired concentration. At a concentration of 0 mg L^{-1}immersion in water was used. After, the cuttings were buried vertically up to 1/3 of its length into rectangular plastic trays (19x12x6 cm) with hinged lid, containing sand as substrate.

Plastic trays remained in mesh with 50% shade. Irrigation was performed daily, observing before the moisture from the substrate.

The experimental design was in completely randomized blocks in a factorial 3 x 3 (mini cuttings sizes x IBA concentrations), with four repetitions, considering the use of 10 mini cuttings per plot.

Evaluations were performed 60 days after implantation of the experiment. The variables analyzed were rooted cuttings (%), cuttings with callus (%), number of primary sprouting, number of roots, number of leaves, length of the three major roots (cm) and dead cuttings (%). Data were submitted to analysis of variance and comparison of averages by Duncan test (p = 0.05) for qualitative factor and regression analysis to quantitative factor. The data of the percentages of rooted cuttings, cuttings with callus and dead cuttings were processed by *arcsine* $\sqrt{x/100}$, and other variables were transformed according to $\sqrt{x+1}$ according to need presented by Lilliefors normality test. For the analysis we used the computer application SANEST (ZONTA and MACHADO, 1984).

3. RESULTS AND DISCUSSION

The interaction, mini cuttings sizes x IBA concentration was significant in all the variables analyzed (Tables 1, 2, 3, 4 and 5), except only for the length of the three major roots and the percentage of cuttings with callus, which were not influenced by the interaction of these factors (Tables 6 and 7), being only by the IBA concentration factor in the percentage of callus (Figure 1).

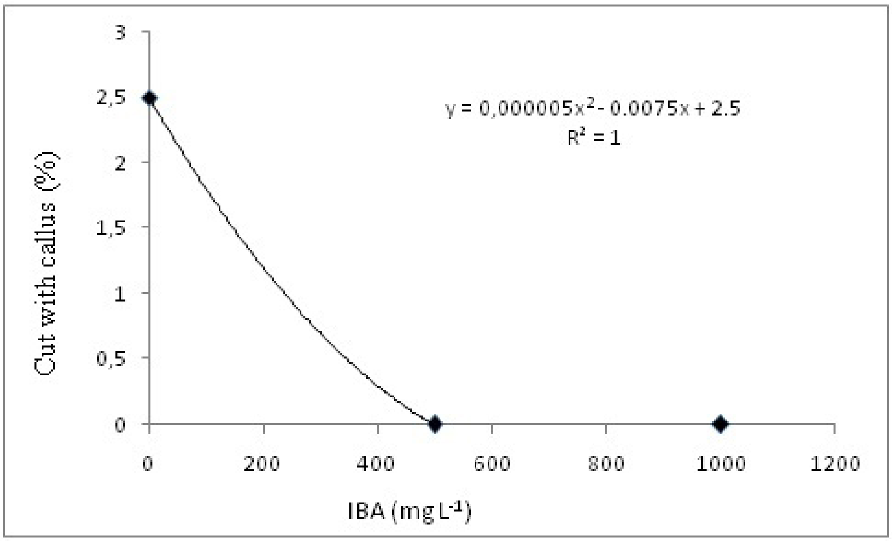

Figure 1. Callogenesis (%), of mini cuttings of roses, according to the size of the cuttings and IBA concentration.
Figura 1. *Calogênese (%), de mini estacas de roseira, com a concentração de AIB.*

By the results obtained in Figure 1, it was found that in the absence of treatment with IBA, it was higher the percentage of cuttings with callus, reducing these values until they have no more callus, from 500 mg $L^{-1}$of IBA. The callus formation process is important because it indicates that cell division and cell differentiation are occurring on cutting base (GEORGE, 1996). Thus, the chance of also have root formation is great, however, both processes are independent (FACHINELLO et al., 1995).

This can be compared by the results in Table 1, with the highest average in the 3 cm cuttings using 0 and 1000 mg $L^{-1}$of IBA, in the 7 cm ones with 500 mg L^{-1} and in the 5 cm ones both concentrations did not differ among themselves, with the use of concentrations between 0 and 1000 mg L^{-1} of AIB the highest rooting averages were obtained with the 3 and 5 cm cuttings, and to 500 mg L^{-1} with the use of length 5 and 7 cm, with emphasis on the last for presenting an average of 82.5%.

Table 1. Mini cuttings of rose bush with roots (%), according to the size of the cuttings and IBA concentration.
Tabela 1. *Mini estacas de roseira enraizadas (%) de acordo com o tamanho das mesmas e concentrações de AIB.*

Size of mini cuttings (cm)	IBA doses (mg L^{-1})		
	0	500	1000
3	28.46 a A	0,00 c B	1,33 a AB
5	24.13 a A	35,10 b A	12,65 a A
7	0.00 b B	82,47 a A	11,20 a B
CV (%)	84.30		

Averages with different letters, lowercase in the same column and uppercase in the same row differ significantly at 5% probability by Duncan test.

However, it was observed that mini cuttings showed a high mortality rate with some cases reaching 100% as for 7 cm cuttings with 0 mg $L^{-1}$of IBA and 3 cm cuttings with 500 mg L^{-1}. However, they ones that remained alive rooted (Table 1). It is assumed that this mortality has been a result of the visual of presence of rust at the cuttings, both at the base and the apex, fast darkening the tissue, which indicates the need for anti-oxidants on them (FACHINELLO et al.,1994; FACHINELLO et al., 2005).

Oxidation is not desirable for the propagation by cuttings, because it hinders the formation of adventitious roots.

The treatment which yielded the highest mortality rate was with mini cuttings and the application of 500 mg $L^{-1}$of IBA in lengths of 5 and 7 cm (Table 2).

Table 2. Mortality of mini cuttings of roses (%) according to the size of the cuttings and IBA concentration.
Tabela 2. *Percentagem de mortalidade de mini estacas de roseira de acordo com o tamanho das mesmas e concentrações de AIB.*

Size of mini cuttings (cm)	IBA doses (mg L^{-1})		
	0	500	1000
3	52.90 b B	100.00 a A	98.66 a A
5	71.43 ab A	64.90 b A	87.34 a A
7	100.00 a A	17.53 b B	63.03 a B
CV (%)	36.50		

Averages with different letters, lowercase in the same column and uppercase in the same row differ significantly at 5% probability by Duncan test.

For the number of primary sprouting and leaves with the concentration of 0 mg L^{-1} the largest average occurred with the 3 to 5 cm cuttings, with 500 mg L^{-1} through the use of the 5 and 7 cm ones and by applying 1000 mg L^{-1} averages were equal to each other (Tables 3 and 4, respectively). In these same variables using mini cuttings of 5 cm it was found statistical similarity between averages according to the concentration of IBA. Mini cuttings of 7 cm obtained the highest average with the application of 500 and 1000 mg $L^{-1}$of IBA. Being in the 3 cm ones, the concentrations of 0 and 1000 mg $L^{-1}$of IBA the ones which showed the highest primary sprouting values (Table 3). About the number of leaves, mini cuttings of 3 cm did not differ with the application of different concentrations of IBA (Table 4).

Table 3. Number of primary sprouting, of mini cuttings of roses, according to the size of the cuttings and IBA concentration.
Tabela 3. *Número de brotação primária de mini estacas de roseira de acordo com o tamanho das mini estacas e as doses de AIB.*

Size of mini cuttings (cm)	IBA doses (mg L^{-1})		
	0	500	1000
3	0.72 a A	0.00 b B	0.22 a AB
5	0.86 a A	0.65 a A	0.42 a A
7	0.00 b B	0.92 a A	0.57 a A
CV (%)	13.60		

Averages with different letters, lowercase in the same column and uppercase in the same row differ significantly at 5% probability by Duncan test.

Table 4. Number of leaves, of mini cuttings of roses, according to the size of the cuttings and IBA concentration.
Tabela 4. *Número de folhas de mini estacas de roseira de acordo com o tamanho das mini estacas e as doses de AIB.*

Size of mini cuttings (cm)	IBA doses (mg L^{-1})		
	0	500	1000
3	4.55 ab A	0.00 b A	2.28 a A
5	7.87 a A	7.82 a A	7.10 a A
7	0.00 b B	9.83 a A	9.50 a A
CV (%)	48.54		

Averages with different letters, lowercase in the same column and uppercase in the same row differ significantly at 5% probability by Duncan test.

Regarding the number of roots, it was observed that with the application of 0 to 1000 mg $L^{-1}$of IBA the averages did not differ among the in different sizes analyzed. However, with 500 mg $L^{-1}$of IBA the larger amounts of roots were formed in 5 and 7 cm mini cuttings (Table 5). This may be a result of these mini cuttings with the two greatest length have a higher carbohydrate content and C:N ratio (MAYER et al., 2002; FACHINELLO et al., 2005), necessary for cell differentiation at the base of the cuttings enabling good rhizogenesis.

Table 5. Number of primary roots, of mini cuttings of roses, according to the size of the cuttings and IBA concentration.
Tabela 5. *Número de raiz primária de mini estacas de roseira de acordo com o tamanho das mini estacas e as doses de AIB.*

Size of mini cuttings (cm)	IBA doses (mg L^{-1})		
	0	500	1000
3	2.75 a A	0.00 b A	0.85 a A
5	2.68 a A	4.90 a A	4.70 a A
7	0.00 a B	9.19 a A	5.74 a A
CV (%)	40.83		

Averages with different letters, lowercase in the same column and uppercase in the same row differ significantly at 5% probability by Duncan test.

Furthermore, it was found that with application of IBA at the basis of the cuttings the averages of formed roots (number) resembled statistically among themselves, which demonstrates the advantage of using this plant growth regulator in the cuttings, making it easier to accelerate the rhizogenesis of the cuttings, but also to obtain more roots (OLIVEIRA et al., 2001; XAVIER et al., 2009). However, without application of this auxin at the basis of the mini cuttings the highest averages were obtained when they were prepared with 3 to 5cm (Table 5).

There was 100% mortality of the 7 cm cuttings that did not receive treatment with IBA (Table 2), thereby damaging the entire root formation process. It is assumed in this case that due to the greater length of this mini cutting the need for water maintenance for survival and subsequent root formation was higher, and once unserved allowed this high mortality. According to Fachinello et al. (1995), among the external factors, water is one of the factors that deserve special attention, required so there could be cell division, because the loss of water is one of the leading causes of cuttings death.

When analyzing the size of the mini cuttings, with 7 cm the best IBA concentration was 500 and 1000 mg L^{-1} and with 3 to 5cm there were no differences (Table 2).

As noted in Table 5, there were a greater number of primary roots with mini cuttings of 5 and 7 cm. These results suggest that the larger cuttings have a higher amount of nutritive reserves, important for metabolic support and responsible for further development and root growth (FACHINELLO et al., 2005).

Table 6. Length of the three major roots (cm) of mini cuttings of roses, according to the size of the cuttings and IBA concentration.
Tabela 6. *Comprimento das três maiores raízes (cm), em mini estacas de roseira, de acordo com o tamanho das mesmas e concentração de AIB.*

Size of mini cuttings (cm)	IBA doses (mg L^{-1})		
	0	500	1000
3	1.42^{ns}	0.00	0.82
5	2.12	3.61	2.40
7	0.00	4.09	2.11
CV (%)	36.63		

^{ns} Non significative.

Table 7. Callogenesis (%), of mini cuttings of roses, according to the size of the cuttings and IBA concentration.
Tabela 7. *Calogênese (%), em mini estacas de roseira, de acordo com o tamanho das mesmas e concentração de AIB.*

Size of mini cuttings (cm)	IBA doses (mg L^{-1})		
	0	500	1000
3	9.66^{ns}	0.00	0.00
5	2.56	0.00	0.00
7	0.00	0.00	0.00
CV (%)	245.71		

^{ns} Non significative.

4. CONCLUSION

For the propagation of roses, Mary Rose variety, it is recommended to use mini cuttings with 5 and 7 cm, treated with 500 mg $L^{-1}$of IBA.

REFERENCES

ALCANTARA, G.B.; FERRONATO, M.L.; LIMA, D.M.; SANTOS, E.C.; SILVA, C.L.; RITTER, M.; BIASI, L.A. Enraizamento de estacas caulinares de brinco-de-princesa com diferentes comprimentos. **Scientia Agraria**, Piracicaba, v.9, n.4, p.575-578, 2008.

ARNALDI, C.R.; PEROSA, J.M.Y. Perdas físicas,energéticas e econômicas em dois sistemasde comercialização de rosas no Estado de São Paulo. **Revista Energia na Agricultura**, Botucatu, v.22, n.3, p.1-14, 2007.

ARRUDA, S.T.; OLIVETTE, M.P.A.; CASTRO, C.E.F. Diagnóstico da floricultura do Estado de São Paulo. **Revista Brasileira de Horticultura Ornamental**, Campinas, v.2, n.2,p.1-18, 1996.

BARBOSA, J.G.; GROSSI, J.A.S.; PIVETTA, K.F.L.; FINGER, F.L.; SANTOS, J.M. Cultivo de rosas. **Informe Agropecuário**, Belo Horizonte, v. 26, n. 227, p. 20-29, 2005.

BORGES, S.R.; XAVIER, A.; OLIVEIRA, L.S.; MELO, L.A.; ROSADO, A.M. Enraizamento de miniestacas de clones híbridos de *Eucalyptus globulus*. **Revista Árvore**,Viçosa,v.35, n.3, p.425-434, 2011.

CASTRO, C.E.F. Cadeia produtiva de flores e plantas ornamentais. **Revista Brasileira de Horticultura Ornamental,** Campinas, v.4, n.1 e 2, p.1-46, 1998.

DONADIO, L.C.; MARTINS, A.B.G.; VALENTE, J.P. **Fruticultura tropical**. Jaboticabal: FUNEP, 1992.268p.

FACHINELLO, J.C.; HOFFMANN, A.; NACHTIGAL, G.R.L.; KERSTEN, E.;FORTES, G.R.L. **Propagação de plantas frutíferas de clima temperado**. Pelotas: UFPEL, 1995. 178p.

FACHINELLO, J.C.; HOFFMANN, A.; NACHTIGAL, J.C. **Propagação de plantas frutíferas**. Brasília: Embrapa Informação Tecnológica, 2005. 221p.

FACHINELLO, J.C.; HOFFMANN, A.; NACHTIGAL, J.C.; FORTES, G.R.L. **Propagação de plantas frutíferas de clima temperado.** Pelotas: Editora e Gráfica Universitária, 1994. 311p.

GEORGE, E.F. **Plant propagation by tissue culture.** 2. ed. England: Exegetics Limited, v.2, 1996. 181p.

HARTMANN, H.T.; KESTER, D.E.; DAVIES JUNIOR, F.T.; GENEVE, R.L. **Plant propagation: principles and practices.**7. ed. New Jersey: Prentice-Hall, 2002. 880p.

HIGASHI, E.N.; SILVEIRA, R.L.V.A.; GONÇALVES, A.N. **Propagação vegetativa de *Eucalyptus***: princípios básicos e sua evolução no Brasil. Piracicaba:IPEF/ESALQ/USP, 2000. 10p. (Circular Técnica, 192).

JUNQUEIRA, A.H.; PEETZ, M. S. Exportações de flores e plantas ornamentais superam US$ 35milhões em 2007: recorde e novos desafios para o Brasil - Análise conjuntural da evolução das exportações de flores e plantas ornamentais do Brasil no período de janeiro a dezembro de 2007. São Paulo, 2013. Disponível em: <http://www.hortica.com.br>. Acesso em: 21 de março 2013.

LANDGRAF, P.R.C.; PAIVA, P.D.O. Agronegócio da floricultura brasileira. **Magistra**, Cruz das Almas, v.21, n.4, p.253-261, 2009.

MAYER, N.A., PEREIRA, F.M.; NACHTIGAL, J.C. Efeito do comprimento de estacas herbáceas de dois clones de umezeiro (*Prunus mume* Sieb & Zucc.) no enraizamento adventício. **Revista Brasileira de Fruticultura**, Jaboticabal, v.24. p.500-504, 2002.

MOTA, P.R.D.; BOAS, R.L.V.; SOUZA, V.F.D.; RIBEIRO, V.Q. Desenvolvimento de plantas de crisântemo cultivadas em vaso em resposta a níveis de condutividade elétrica. **Engenharia Agrícola**, Piracicaba, v.27, n.1, p.65, 2007.

OLIVEIRA, M.C. OLIVEIRA, M.C.; RIBEIRO, J. F.; RIOS, M.N.S; REZENDE, M.E. **Enraizamento de estacas para a produção de mudas de espécies nativas de matas de galeria**. Brasília: EMBRAPA Cerrados, 2001. 4p. (Recomendação Técnica n.41).

ONO, E.O.; FORTES, A.M.T.; RODRIGUES, J.D.; CAMBRIA, S.Efeitos de diferentes concentrações de ANA no enraizamento de Estacas de rosa. **Agronomia**, Rio de Janeiro, v.38, n.1, p.11-15, 2004.

PIZZATTO, M.; WAGNER JÚNIOR, A.; LUCKMANN, D.; PIROLA, K.; CASSOL, D.A.; MAZARO, S.M. Influência do uso de AIB, época de coleta e tamanho de estaca na propagação vegetativa de hibisco por estaquia. **Revista Ceres**,Viçosa, v.58, n.4, p. 487-492, 2011.

REGO, J.L.; VIANA, T.V.A.; AZEVEDO, B.M.; BASTOS, F.G.C.; GONDIM, R.S. Efeitos de níveis de irrigação sobre a cultura do crisântemo. **Revista Ciência Agronômica**, Fortaleza,v.35, p.302-308, 2004.

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

XAVIER, A.; WENDLING, I. **Miniestaquia na clonagem de *Eucalyptus*.** Viçosa: SIF,1998. 10p. (Informativo Técnico SIF, 11).

XAVIER, A.; WENDLING, I.; SILVA, R.L. **Silvicultura clonal: Princípios e técnicas.** Viçosa: Ed. UFV, 2009. 272p.

ZONTA, E.P.; MACHADO, A.A. **Sistema de Análise Estatística (SANEST).** Pelotas: UFPEL, Instituto de Física e Matemática, 1986. 399p.