Substrate Effects on the Rooting Response of *Bougainvillea* Stem Cuttings

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ABSTRACT

Bougainvillea spectabilis Willd. is an interesting plant for home and urban landscaping, since it blooms throughout the year and shows a wide variety of bract colors, in addition to being tolerant to water stress. The rooting of stem cuttings of bougainvillea is usually small and could be associated with the type of substrate that is used. The objective of this work was to evaluate the substrate effects on rooting response of bougainvillea stem cuttings. Two experiments were carried out in a completely randomized design with ten replications. The treatments were: 'red sand' (RS), 'coarse sand' (CS), RS + CS, RS + weathered carnauba straw (*Copernicia cerifera* Mart.) (WCS), CS + WCS, and RS + CS + WCS. The analysis of a CS sample indicated an apparent density of 1.21 mg m^{-3}, moisture retention of 8.00 (0.01 Mpa), 10.2 mm and 51.03 mm m^{-1} available water and, the following components expressed as g kg^{-1}: 904 coarse sand, 85 fine sand, 4 silt, and 7 clay. The corresponding values for RS were 1.20 mg m^{-3}, 10.96 (0.01 Mpa), 5.52, 13.1 mm, 65.28 mm m^{-1} and 405, 556, 5, and 34 in the granulometric fractions. Greater rooting percentages were obtained with the use of CS (24%) or CS + RS (28%). In the second experiment, WCS was replaced with vermicompost (VC). Greater rooting percentages were obtained with CS + VC (73%).

Key words: *Bougainvillea spectabilis* Willd., *B. glabra* Choisy, cutting propagation, ornamental plants.

RESUMO

Efeitos do substrato no enraizamento de estacas caulinares de *Bougainvillea*

A *Bougainvillea spectabilis* Willd. é interessante, nas arborizações residencial e urbana, porque floresce durante todo o ano e apresenta variação de cores de brácteas e tolerância a estresses hídricos. A percentagem de pegamento das estacas da buganvília é, em geral, pequena e pode estar associada ao substrato usado. O objetivo do trabalho foi avaliar os efeitos do substrato sobre a percentagem de enraizamento de estacas de buganvília. Dois experimentos foram realizados, num delineamento inteiramente casualizado, com dez repetições. No primeiro, os tratamentos foram: 'areia vermelha' (AV), 'areia grossa' (AG), AV + AG, AV + palha de carnaubeira (*Copernicia cerifera* Mart.) curtida (PC), AG + PC e AV + AG + PC. A análise de uma amostra de AG indicou densidade aparente de 1,21 mg m^{-3}, retenção de umidade de 8,00 (0,01 Mpa), 10,2 mm e 51,03 mm m^{-1} de água disponível e, em g kg^{-1}: 904 de areia grossa, 85 de areia fina, 4 de silte e 7 de argila. Os valores respectivos para AV foram de 1,20 mg m^{-3}, 10,96 (0,01 Mpa), 13,1 mm, 65,28 mm m^{-1} e 405, 556, 5 e 34 nas frações granulométricas. Maiores percentagens de estacas enraizadas foram obtidas com o uso de AG (24%) ou AG + AV (28%). No segundo experimento, PC foi substituída por húmus de minhoca (HM). Maior percentagem de estacas enraizadas foi obtida com AG + HM (73%).

Palavras-chave: *Bougainvillea spectabilis* Willd., *B. glabra* Choisy, estaquia, plantas ornamentais.

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1. INTRODUCTION

Floriculture encompasses cultivation of flowers and ornamental plants for a variety of purposes, from cut flower crops to the production of tall tree seedlings (CASTRO, 1998). In Brazil, floriculture is not a novel activity, and is practiced in an increasingly intensive manner, probably due to the development of communication and transportation means. Such development has facilitated flower and ornamental plant imports and exports since the mid 1990's (KÄMPF, 1997). Nowadays, it is a well-established activity of economic importance in many states in the Brazilian northeastern region (CASTRO, 1998). Rio Grande do Norte stands out as a state that is a large-scale exporter of fruits; this exporting activity can be extended to flowers and ornamental plants. The United States, Japan, and many European countries have a high demand for these products, which is not being met (MATSUNAGA, 1997).

The genus *Bougainvillea* includes 14 species, most of which have a shrubby to arboreal habit, sometimes thorny, and with a climbing, upright growth habit. The area of occurrence of this genus is located between the tropical and subtropical regions of South America. The most common species, when it comes to landscaping, are *B. glabra* Choisy and *B. spectabilis* Willd., which are very similar between themselves; this similarity sometimes makes it difficult to tell from one another. In Rio Grande do Norte, as well as in other states of the Northeast, cultivation of both species is quite common, with *B. spectabilis* being more frequent, in home and urban landscapings. Interest in bougainvilleas stems from the fact that they bloom throughout the year and present a variety of bract colors, in addition to being tolerant to water stresses.

One of the problems in bougainvillea cultivation concerns its form of propagation, usually done by means of stem cuttings. The percentage of cuttings that 'take' (experience rooting) is usually small. This problem causes increased amounts of labor, time and materials for seedling production, including the propagation material itself. The problem could be caused by the substrate that is utilized for propagation. Many authors (AL-SALEM & KARAM, 2001; JAMES & IERSEL, 2001; LIMA et al., 1997; SOUZA et al., 1995; VIEIRA NETO, 1998) demonstrated that the substrate can influence ornamental plant propagation.

The objective of this work was to evaluate substrate effects on rooting response of stem cuttings of bougainvillea (*B. glabra*).

2. MATERIAL AND METHOD

Two experiments were carried out in a shade house at Universidade do Estado do Rio Grande do Norte (UERN), located in the municipality of Mossoró, RN, Brazil. The shade house walls and ceiling were built with black nylon screen, providing an interception of approximately 50 % of the incident light. Data for some climatic factors were measured during the experimental period at a weather station located 3 km from the shade house (Table 1). The two experiments will be identified, through the rest of this paper, as Experiment-1 and Experiment-2, respectively. A completely randomized design was utilized in both experiments, with six treatments and ten replicates. Each plot consisted of ten 1 l-capacity black plastic bags, pierced in their bottom third. Planting was carried out by hand. Cuttings were 25 cm long with diameters ranging between 0.70 cm and 2.00 cm. Irrigation of the bags containing the substrates start-

Table 1. Values for some climatic factors in pertinent months of 2001 and 2002 in Mossoró, RN, Brazil

Climatic factor	2001						2002	
	Jun.	Jul.	Aug.	Sept.	Nov.	Dec.	Jan.	Feb.
Max. air temperature (°C)	33.3	34.0	34.8	35.4	34.8	35.6	31.1	33.7
Min. air temperature (°C)	22.6	21.5	21.2	22.5	24.2	24.7	25.0	22.9
Relative humidity (%)	76.0	68.9	58.2	63.1	65.8	67.7	83.3	78.6
Precipitation (mm)	53.2	16.3	2.2	0.0	0.0	7.8	321.1	41.9
Piche evaporation (mm)	5.6	6.2	7.7	8.6	8.2	8.2	3.3	5.8
Mean wind speed (m/s)	3.6	4.2	4.6	6.0	5.5	5.2	2.1	2.8
Insolation (h $month^{-1}$)	214	273	301	303	288	254	56	234
Cloud cover	4.5	2.8	2.0	1.9	2.0	3.0	3.7	3.9

ed five days before planting. The plants were irrigated with 1/2 l water/bag, applied at three daily times: in the beginning of the morning, at noon, and by the end of the afternoon. Weed control was performed every day by hand, starting on the seventh day after planting.

Experiment-1 was carried out in the period from 6.05.01 to 9.15.01. The treatments under evaluation were as follows: 'red sand' (RS), 'coarse sand' (CS), 'red sand' + 'coarse sand', 'red sand' + weathered carnauba straw (*Copernicia cerifera* Mart.), 'coarse sand' + weathered carnauba straw, and 'red sand' + 'coarse sand' + weathered carnauba straw. The physical analysis of a 'coarse sand' sample indicated an apparent density of 1.21 mg m^{-3}, moisture retention of 8.00 (0.01 Mpa), 10.2 mm and 51.03 mm m^{-1} available water, and the following components expressed as g kg^{-1}: 904 coarse sand, 85 fine sand, 4 silt, and 7 clay. The corresponding values for 'red sand' were 1.20 mg m^{-3}, 10.96 (0.01 Mpa), 13.1 mm, 65.28 mm m^{-1} and 405, 556, 5, and 34 in the granulometric fractions. In the case of substrate mixtures, equal proportions of each component were utilized, in terms of volume; proportions were uniformly mixed. After being mixed, the substrates were sifted through a 3.2 mm diameter mesh. The chemical analysis results for substrates are presented in Table 2.

Planting for Experiment-2 was carried out on 11.10.01 and the harvest was performed 96 days later. The substrates evaluated were the same as in Experiment-1, but carnauba straw was replaced with vermicompost. The chemical analysis results for the substrates are presented in Table 3.

In both experiments, evaluations consisted of: percentage of rooted cuttings, length of the longest branch, and dry matter mass of the above-ground part and of the root system. Cuttings with a minimum of one root at least 1 cm long were considered as rooted. Collection of stake materials (above-ground part and root) was done on a single day. After collecting, the materials were placed in a forced air circulation oven, adjusted to a temperature of 65°C, where they remained for seven days. The data were statistically analyzed according to recommendations by ZAR (1999). The means were compared by Tukey test at 5% probability.

Table 2**.** Chemical analysis results of substrate samples utilized for bougainvillea propagation

Substrate	pH (1:2.5)			Ca	Mg	K	Na	Al	P
	H_2O	KCl	$CaCl_2$	$cmol_c/dm^3$					mg/dm^3
Red sand (RS)	5.0	4.2	4.7	1.30	0.50	0.06	0.04	0.25	2
Coarse sand (CS)	8.7	7.4	7.8	1.80	0.90	0.07	0.16	0.00	37
RS + CS	6.1	5.1	5.7	1.40	1.10	0.05	0.16	0.10	16
RS + straw (S)	4.8	4.0	4.6	3.40	2.10	0.35	0.13	0.25	31
CS + S	5.8	4.9	5.4	3.30	2.00	0.38	0.20	0.15	48
RS + CS + S	5.6	4.7	5.2	2.90	1.60	0.35	0.18	0.00	41

[1] Analyses carried out at Laboratório de Solos of Escola Superior de Agricultura de Mossoró.

Table 3**.** Chemical analysis results of substrate samples utilized for bougainvillea propagation

Substrate	pH (1:2.5)			Ca	Mg	K	Na	Al	P
	H_2O	KCl	$CaCl_2$	$cmol_c/dm^3$					mg/dm^3
Red sand (RS)	4.7	3.9	4.5	1.00	0.90	0.11	0.17	0.15	2
Coarse sand (CS)	8.2	6.9	7.4	1.90	0.90	0.09	0.24	0.00	43
RS + CS	6.0	5.0	5.6	1.90	0.90	0.12	0.21	0.00	50
Red sand + vermicompost (VC)	7.0	5.9	6.4	8.00	3.40	0.48	0.55	0.00	349
CS + VC	7.3	6.2	6.7	12.00	2.60	0.75	0.59	0.00	755
RS + CS + VC	6.9	5.8	6.3	7.60	5.60	0.57	0.60	0.00	451

[1] Analyses carried out at Laboratório de Solos of Escola Superior de Agricultura de Mossoró.

3. RESULTS AND DISCUSSION

With regard to the percentage of sprouted (mean length of longest branch and dry matter in above-ground part) and rooted cuttings, the best results were obtained with the use of 'coarse sand', either alone or mixed with 'red sand' (Table 4). The 'coarse sand' plus carnauba straw mixture provided the greatest mean length for the longest bougainvillea branch. In spite of this fact, this treatment only differed significantly from 'red sand' as a substrate. In the case of dry matter weight in the above-ground part of plants, the highest means were obtained with 'coarse sand' + 'red sand' + carnauba straw, and coarse sand + carnauba straw mixtures. No differences between treatments were observed for dry matter weight in the root system. It can be seen, therefore, that the best treatment depends on the trait that is being evaluated. The carnauba straw seems to be an interesting substrate to stimulate growth, especially for shoots in the above-ground part of the plant, but not to increase the proportion of rooted cuttings.

The bougainvillea cuttings characteristics, 96 days after burying, in the experiment where vermicompost replaced carnauba straw, are presented in Table 5. The 'coarse sand' + vermicompost treatment provided the greatest percentage of sprouted cuttings. The three treatments that provided the greatest mean length of the longest bougainvillea branch were those where vermicompost was present. The 'coarse sand' + vermicompost, and 'red sand' + vermicompost treatments provided the greatest dry matter weights in the above-ground part of the plant and in the root system.

Apparently, carnauba straw, and also vermicompost, favor growth of the root system and of the above-ground part of bougainvillea plants, possibly because they improve the physical, chemical, and biological properties of the substrate. Results obtained by several authors (ALVES & PASSONI, 1997; JAMES & IERSEL, 2001; SOUZA et al. 1995) support, to a certain extent, the results found in the present work. SOUZA et al. (1995) verified that a substrate containing soil + sand + carbonized rice hulls promoted greater growth in daisies (*Chrysanthemum morifolium* Ramat.) due to greater water availability and aeration, according to the authors. The plants showed smaller growth in the soil + sand substrate, probably due to compaction. In this

Table 4. Bougainvillea cutting characteristics, 102 days after burying, in relation to types of substrates

Substrates	Rooted cuttings	Mean length of longest branch	Dry matter in above-ground part	Dry matter in root system
	%	cm	g	
Coarse sand (CS)	24 a	12.4 ab	1.40 ab	0.38 a
Red sand (RS)	14 ab	3.2 b	0.41 b	0.09 a
CS + RS	28 a	8.5 ab	0.76 ab	0.20 a
CS + carnauba straw	14 ab	25.9 a	2.99 a	0.48 a
RS + carnauba straw	7 b	12.5 ab	1.67 ab	0.34 a
CS + RS + carnauba straw	17 ab	20.3 ab	2.99 a	0.56 a
C.V. %	75	69	64	81

Table 5. Bougainvillea cutting characteristics, 96 days after burying, in relation to types of substrates

Substrates	Rooted cuttings	Mean length of longest branch	Dry matter in the above-ground part	Dry matter in root system
	%	cm	g	
Coarse sand (CS)	53 bcd	13.8 b	1.36 bc	0.30 bc
Red sand (RS)	45 cd	11.6 b	0.67 c	0.13 c
CS + RS	39 d	19.3 ab	1.44 bc	0.24 bc
CS + vermicompost	73 a	27.2 a	4.28 a	0.55 a
RS + vermicompost	68 ab	29.5 a	4.37 a	0.55 a
CS + RS + vermicompost	63 abc	24.3 a	3.11 ab	0.36 ab
C.V. %	18	38	47	17

work, the poorest bougainvillea growth means were obtained with the use of red sand, with higher percentages of small granulometric fractions, thus favoring compaction. The growth of petunias (*Petunia × hybrida* Hort. Vilm. Andr.) was also better on a medium with greater porosity (JAMES & IERSEL, 2001). Several characteristics relative to the root system of *Arbutus andrachne* L. cuttings were improved by increasing the amount of perlite in the substrate (AL-SALEM & KARAM, 1997).

Since the experiments were performed during different seasons (Table 1), the season when the cuttings were collected and the environment conditions under which they were planted were also different. Therefore, a joint analysis with common treatments perhaps would not be convenient. However, from a practical standpoint, considering the results from experiments 1 (Table 4) and 2 (Table 5), it seems that the utilization of a mixture, in equal parts, of 'coarse sand' and vermicompost could be recommended for bougainvillea seedling production from stakes (cuttings). The 'coarse sand' + vermicompost mixture was much richer in nutrients than the 'coarse sand' + carnauba straw mixture (Tables 2 and 3), and this must have contributed toward the better results obtained with vermicompost than with the other substrates. Therefore, apparently, the type of organic matter utilized to compound the substrate for bougainvilleas is relevant.

5. CONCLUSIONS

Greater cutting rooting percentages can be obtained with the use of coarse sand (24%), coarse sand + red sand (28%), and coarse sand + vermicompost (73%). The type of substrate influences cutting characteristics differently as to aerial part and root system.

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