Evaluation of suitable rooting media for Bougainvillea (*Bougainvillea spectabilis*) stem cuttings and frequency of flowering

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ABSTRACT

Bougainvillea spectabilis is primarily propagated by stem cuttings. But problems associated with rooting of stem cuttings are obstacle for vegetative propagation. Therefore present study was conducted to identify proper maturity stage of stem cuttings and appropriate medium for *Bougainvillea spectabilis* for optimum flowering. The experiment was carried out in a plant propagator at the Floriculture Research Unit of the National Botanic Gardens Peradeniya by using three different stem cuttings (Soft wood, Semi hard wood and Hard wood) planted in three different media (Sand + Coir dust + Compost, Sand + Coir dust, and Coir dust only). The experimental design was two factor factorial laid out in 9 treatments with 3 replicates. Data was collected at 21 days after propagation and subsequent data gathered at 10 days interval, i.e. number of new leaves, number of roots, number of shoots and height of the plant. Data were tabulated and analyzed by using Analysis of Variance (ANOVA) procedure of Statistical Analysis System (SAS). Duncan's New Multiple Range Test (DNMRT) was performed to compare the difference among treatment means at p=0.05. In the first experiment, Semi hard wood cuttings performed best in the Coir dust + Sand (1:1) rooting medium. In the second experiment selected cutting type i.e. Semi hard wood and the best medium i.e. Coir dust + Sand was used to study the effect of different fertilizer applications on flowering frequency of *Bougainvillea*. The second experiment was arranged in a Completely Randomized Design (CRD) with five treatments, i.e. Maxi crop (control), Maxi crop + NPK (10:11:18), Maxi crop + NPK (10:52:10), Maxi cop + NPK (20:20:20), Maxi crop + NPK (6:30:30). According to the overall study findings, the best medium for rooting was the mixture of Sand + Coir dust in equal proportions while Maxi crop + NPK (6:30:30) applied at weekly intervals was the best treatment for optimum flowering frequency of *Bougainvillea spectabilis.*

Key words: ***Bougainvillea spectabilis*, rooting media, stem cuttings, fertilizer, flowering frequency**

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INTRODUCTION

Bougainvillea (*Bougainvillea spectabilis*) is one of the most popular flowering plant belongs to family Nyctaginaceae (Hammad, 2009). Special characteristics of *Bougainvillea*, i.e. high variation in foliage, production of many flowering inflorescence and continuous blooming with short production cycle has been very useful in ornamental industry (Kobayashi at el, 2007). *Bougainvilleas* are primarily propagated by stem cuttings, i.e. soft wood, semi hard wood and hard wood stem parts can be used for propagation. But lack of competence to form adventitious roots by cuttings occurs routinely and is an obstacle for the vegetative propagation (Celine *et al*., 2006). Bougainvillea has extremely fine root system. Therefore it should be planted in well drained soil. Studies have shown that the ability of plants to form roots is influenced by physiology state of the stock plant, propagating environment, and the treatment applied to the cuttings prior to rooting (Hackett *et a*l., 1972). Adventitious root formation is a key step in vegetative propagation and problems associated with rooting of cuttings frequently result in significant economic losses (De Klerk *et al.,* 1999). In the light of

this situation it is important to increase the rooting frequency of *Bougainvillea* to induce adventitious root formation and enable rooting of cuttings with minimal economic loss. Therefore present study was conducted to identify proper maturity stage of stem cuttings and appropriate medium for *Bougainvillea spectabilis* for optimum flowering.

METHADOLOGY

Experiment I

Evaluation of most suitable rooting media Bougainvillea stem cuttings: The experiment was carried out in a plant propagator at the Floriculture division of the National Botanic Gardens, Peradeniya from January 2013 to October 2013. Planted *Bougainvillea* stem cuttings were kept in the propagator (10×2') covered with nylon mesh to intercept 50% of the incident radiation.

Preparation of rooting media:Three types of rooting media, i.e. coir dust + sand + compost, coir dust + sand, coir dust were prepared. The all the materials were mixed into 1 : 1 : 1 ratio and filled into 12cm height black polythene covers.

Selection, preparation and planting of stem cuttings: Stem cuttings were selected from a *Bougainvillea speactabilis* variety which has purple flowers. **C**uttings were collected in the morning and kept moist. Stem cuttings at three different maturity stages, i.e. Soft wood (SW), Semi-hard wood (SHW) and Hard wood (HW)) were planted in three different rooting media. Each stem cuttings were dipped in a hormone solution (Rapid root) before planting. All cuttings were kept in a polythene propagator for 21 days. Coir dust was used as a bedding material in the floor of the propagator and watered.

Design of the Experiment: The experimental design was two factor factorial laid out in 9 treatments with 3 replicates. Each replication consisted of twelve cuttings as given below. T_1 - Sand + Coir dust + Compost (Semi hard wood) ,T_2 - Sand + Coir dust + Compost (Soft wood),T_3 - Sand + Coir dust + Compost (Hard wood),T_4 - Coir dust + Sand (Semi hard wood),T_5 - Coir dust + Sand (Soft wood),T_6 - Coir dust + Sand (Hard wood),T_7 - Coir dust only (Semi hard wood),T_8 - Coir dust only (Soft wood),T_9 - Coir dust only (Hard wood)

Data collection: Data were collected at 21 days after propagation and subsequent data gathered at 10 days interval, i.e. number of new leaves, number of roots, number of shoot and plant height.

Statistical Analysis: Data were tabulated and analyzed by using Analysis of Variance (ANOVA) procedure of Statistical Analysis System (SAS). Duncan's New Multiple Range Test (DNMRT) was performed to compare the difference among treatment means at p=0.05.

Experiment II

Effect of fertilizer on flowering of rooted cuttings:In the second experiment selected cutting type i.e. Semi hard wood and the best medium i.e. Coir dust + Sand was used to study the effect of different fertilizer applications on flowering frequency of *Bougainvillea*.

Design of the experiment: The second experiment was arranged in a Completely Randomized Design (CRD) with five treatments, i.e. Maxi crop (control), Maxi crop + NPK (10:11:18), Maxi crop + NPK (10:52:10), Maxi cop + NPK (20:20:20), Maxi crop + NPK (6:30:30).

***Data collection*:** Data were collected 41 days after propagation and subsequent data gathered at 10 days interval, i.e. number of shoots, number of flowers and number of leaves.

Statistical Analysis: Data were tabulated and analyzed by using Analysis of Variance (ANOVA) procedure of Statistical Analysis System (SAS). Duncan's New multiple Range Test (DNMRT) was used to compare the differences among treatment means at p=0.05. Linear Correlation Analysis was used to determine the strength of the

RESULTS AND DISCUSSION

Experiment I

Evaluation of most suitable rooting media for planting of Bougainvillea stem cuttings

Effect of different rooting media on leaves formation of Bougainvillea stem cuttings:

Average number of leaves produced by cuttings under different rooting media ranged from 2.95-6.8. Semi hard wood produced the highest number of leaves as 6.8 in the M2 (Coir dust + Sand) media the second highest 5.5 in the M1 (Coir dust+ Sand + Compost). Hard wood cuttings produced the equal number of leaves in the rooting media M2 and M3 (Table1).

Table 1 Effect of different treatments on number of leaves of *Bougainvillea* stem cuttings

	M1		M2		M3	
SHW	5.53	± 0.07	6.80	± 0.39	5.03	± 0.25
SW	3.21	± 0.15	3.30	± 0.17	2.95	± 0.08
HW	5.35	± 0.27	5.06	± 0.23	5.06	± 0.17

Note: Measurements are the means of 15 replicates ± SE. SHW - Semi hard wood, SW - Soft wood, HW - Hard wood, M1 - Coir dust + Sand + Compost, M2 - Coir dust + Sand, M3 - Coir dust only

Effect of different rooting media on roots formation of Bougainvillea stem cuttings: The overall result about root formation shows that semi hard wood (SHW) produced more number of roots in media 1 (Coir dust + Sand + Compost), 2 (Coir dust + Sand) and 3 (Coir dust only) respectively. The lowest number of roots was observed in soft wood cuttings planted in the rooting medium 1 (Coir dust + Sand + Compost). Soft wood cutting produced less number of roots in all media. The second highest number of roots was produced in hard wood cuttings planted in the rooting medium 3 (Coir dust only) (Table 2). According to the Hudsen *et al*., 1997, soft wood cuttings generally root easier and quicker than semi hard wood and hard wood of *Woodfordia fruticosa.* Furthermore, studies on *Alamanda cathartic* Singhe (1980) and *Memecylon umbelatum* Senarathne and Yakandawala (2004) soft wood cutting recorded the highest rooting percentage.

Table 2 Effect of different treatments on number of roots of *Bougainvillea* stem cuttings

	M1		M2		M3	
SHW	3.03	± 0.07	4.98	± 0.40	3.08	± 0.17
SW	1.43	± 0.05	2.40	± 0.13	1.71	± 0.32
HW	2.61	± 0.18	3.06	± 0.15	3.20	± 0.25

Note: Measurements are the means of 15 replicates ± SE. SHW - Semi hard wood, SW - Soft wood, HW - Hard wood, M1 - Coir dust + Sand + Compost, M2 - Coir dust + Sand, M3 - Coir dust only

Effect of different rooting media on shoots formation of Bougainvillea stem cuttings

Semi hard wood stem cuttings produced the highest number of shoots 5.1 in the M2 (Coir dust + Sand). The second highest number of shoots was produced in hard wood stem cuttings planted in the rooting medium 2 (Coir dust + Sand).Hard wood stem cuttings in the rooting media M1and M2 produced the equal number of shoots accounted to 3.26. The lower numbers of shoots produced by soft wood stem cuttings planted in the M1 (Coir dust + Compost + Sand). It was clear from the study that semi hard wood cuttings of *Bougainvillea* produced highest number of shoots (Table 3).

Table 3 Effect of different treatments on number of shoots of *Bougainvillea* stem cuttings

	M1		M2		M3	
SHW	2.95	± 0.18	5.13	± 0.46	3.16	± 0.20
SW	1.38	± 0.11	2.10	± 0.43	1.96	± 0.24
HW	3.26	± 0.15	3.28	± 0.29	3.26	± 0.05

Note: Measurements are the means of 15 replicates ± SE. SHW - Semi hard wood, SW - Soft wood, HW - Hard wood, M1 - Coir dust + Sand + Compost, M2 - Coir dust + Sand, M3 - Coir dust only

Effect of different rooting media on height of Bougainvillea plants

Semi hard wood cuttings planted in the medium M2 achieved the highest plant height of 10.10 cm and second highest in the rooting medium M1. The height of the plant in the soft wood cuttings gave lower values than the other types of cuttings irrespectively of rooting mediums. Hard wood cuttings planted in the medium M1, M2 and M3 gave the height 9.44 cm, 8.58 cm and 8.80 cm respectively (Table 4).

Table 4 Effect of different treatments on plant height (cm)

	M1		M2		M3	
SHW	9.69	± 0.30	10.10	± 0.51	8.73	± 0.38
SW	6.62	± 0.29	6.59	± 0.00	6.70	± 0.20
HW	9.44	± 0.15	8.58	± 0.11	8.80	± 0.15

Note: Measurements are the means of 15 replicates ± SE. SHW - Semi hard wood, SW - Soft wood, HW - Hard wood, M1 - Coir dust + Sand + Compost, M2 - Coir dust + Sand, M3 - Coir dust only

Experiment II

Effect of fertilizer on flowering of rooted cuttings

The highest number of flowers were recorded from treatment 5 (Maxi crop + NPK 6:30:30) while the lowest number flowers were recorded in treatment 3 (Maxi crop + NPK 10:52:10). There was no significant difference ($p>0.05$) between treatment 1 (Maxi crop) treatment 2 (10:11:18 N: P: K + Maxi crop) treatment 3 (Maxi crop + NPK 10:52:10) and treatment 4 (Maxi crop + NPK 20:20:20) (Table 4). Flowering is a complex process in plants life for which the plants requires optimum growth and nutrients and thus the media containing more nutrients produced higher number of

flowers. More Dahlia flowers obtained in (Sand + Silt + Leaf mould) (Kiran et al., 2007). The similar results were observed by Ahmad, (1989) who reported that the number of flowers was highest for rose grown in the mixture of leaf mold garden soil and sand.

Table 5 Effect of different fertilizer applications on number of flowers per plant during the study period

Fertilizer	Treatments	51DAP	61DAP	71DAP	81DAP
Maxi Crop	T1	4.00^{b}	5.33^{b}	3.66^{b}	2.66^{c}
MC + 10:11:18	T2	5.00^{b}	6.00^{b}	3.00^{b}	4.33^{cb}
MC + 10:52:10	T3	2.66^{b}	4.00^{b}	3.66^{b}	5.00^{cb}
MC + 20:20:20	T4	2.67^{b}	5.00^{b}	5.33^{b}	6.33^{b}
MC + 6:30:30	T5	9.00^{a}	9.66^{a}	12.00^{a}	12.66^{a}

Note: Means with the same letter/s are not significantly different at p= 0.05

Correlation Analysis

When Linear Correlation Analysis was performed for no number of leaves (NL), number of roots (NR), number of shoots (NS), length of shoots (LS), length of roots (LR) and plant height (HP) showed a highly significant positive correlation ($p<0.0001$). The number of flowers (NF) showed a significant negative correlation ($p=0.05$) with number of leaves (NL) and plant height (PH). On the other hand, there is no significant relationship ($p=0.05$) between number of roots (NR), number of shoots (NS), length of shoots (LS) and length of the roots (LR) with nunber of flowers (NF) of *Bougainvillea spectabilis* (Table 6)

Table 6 Linear Correlation Coefficient between growth parameters of number of leaves, number of roots number of shoots, length of roots, length of roots and number of flowers for the overall data set

	NL	NR	NS	LS	LR	PH	NF
NL	-	-	-	-	-	-	-
NR	0.973***	-	-	-	-	-	-
NS	0.940***	0.955***	-	-	-	-	-
LS	0.716***	0.700***	0.686***	-	-	-	-
LR	0.954***	0.925***	0.940***	0.759***	-	-	-
PH	0.695***	0.601***	0.638***	0.476***	0.647***	-	-
NF	-0.124*	-0.079^{ns}	-0.040^{ns}	0.080^{ns}	-0.046^{ns}	-0.110*	-

Note:***= Significant at $p<0.0001$, *Significant at $p<0.05$; NS= non siginificnt NL- number of leaves, NR- number of roots, NS- number of shoots, LR- length of root, LS- length of shoots, PH- Plant hiegt NF- number of flowers

CONCLUSION

In the first experiment, Semi hard wood cuttings performed best in the Coir dust + Sand (1:1) rooting medium. The best maturity stage of cuttings of *Bougainvillea spectabilis* for efficient rooting was Semi hard wood. In the second experiment selected cutting type i.e. Semi hard wood and the best medium i.e. Coir dust + Sand was used to study the effect of different fertilizer applications on flowering frequency of *Bougainvillea*. According to the overall study findings, the best medium for rooting was the mixture of Sand + Coir dust in equal proportions while Maxi crop + NPK (6:30:30) applied at weekly intervals was the best treatment for optimum flowering frequency of *Bougainvillea spectabilis.*

REFFERENCES

Ahmad, K.K., (1989). Effect of different potting media on different rose cultivars under plastictunnel, M.sc. Hons Thesis, NWFP. Agriculture University, Pesawar, Pakistan.

Celine S, Luc N, Thierry B, Helene C, Marie-Pierre J, Marlene D, Goran S, Michel Z, Catherine B, (2006). Proteomic Analysis of Different Mutant Genotypes of Arabidopsis Led to the Identification of 11 Proteins Correlating with Adventitious Root Development. Plant Physiol. 140: 349 – 364.

De Klerk G.J, Van Der Krieken W.M, De Jong J.C (1999). The formation of adventitious roots;new concepts, new possibilities. In Vitro Cell Dev Biol. 35: 189- 199.

Hackett, W. P., R. M. Scachs, and J.Debie. (1972). Growing Bougainvellia as a flowering pot plant.California.Agriculture.26 (8): 12 – 13.

Hammad, I. (2009). Genetic variation among Bougainvillea glabra cultivars (Nyctaginaceae) detected by Rapid markers and Isozymes patterns. Journal of Agriculture and Biological sciences 5 (1): 63-71.

Hudsen, T.H., E. K., Dale, T.D., Fred and L. G. Robert (1997). Techniques of propagation by cuttings. Plant propagation principles and practices. eds, J. Williams, C. Cobb and B.Cappuccio, 329 – 338.

Kiran, M, Baloch, J.U.D. and Waseem, M. (2007). Effect of different growing media on the grown and development of Dahilia (*Dahlia pinnata*) under the Agro-climatic condition of Dera Ismail Khan. Department of Horticulture, Faculty of Agriculture, Gomal University 10 (20): 4140 – 4143.

Kobayashi, D.K., McConnell, J., Griffis, J. (2007). Bougainvillea. Available from the Department of Tropical Plant and Soil Sciences, published by the College of Tropical Agriculture and Human Resources.

Senarathne, M.P.I. and Ykandawala, K. (2004). Propagation and Landscape Potential of Korakaha (*Memecylon umbellatum* Burm. F). Faculty of Agriculture and Plantation Management, Wayaba University, 326 – 336.

Singhe, S.P. (1980). Mist Propagation of *Allamanda cathartica* by different types of stem cuttings, Plant Science, 42 – 43.