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Effect of Different Potting Media on Growth and Flowering of Bougainvillea sp.

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Abstract

This study was conducted at the Ornamental Plants Nursery of the Department of Horticulture, Faculty of agriculture, University of Khartoum, Shambat, Sudan during 2015. The objective was to study the effect of mixing silty soil/SS (Revarian sediments) and field soil with compost and leaf mould (organic amendments) at different ratios on growth and flowering of bougainvillea (Bougainvillea sp.). Bougainvillea transplants were potted into polyethylene bags (40 cm diameter and 50 cm height) containing the following media as treatments: silty soil (SS) 100%, SS 75% + compost 25%, SS 50% + compost 50%, SS 75% + leaf mould 25%, SS 50% + leaf mould 50%, field soil 100%, field soil 75% + compost 25%, field soil 50% + compost 50%, field soil 75%+leaf mould 25%, field soil 50% + leaf mould 50%. Treatments were arranged in a randomized complete block design and replicated thrice. Three plants represented an experimental unit. Data were collected on plant height, number of branches per plant, number of leaves per plant, stem diameter, plant fresh and dry weights, and number of inflorescences per plant. Bougainvillea plant response towards organic amendments was higher in SS than in field soil. The treatment SS 75% + compost 25% resulted in highest plant height, stem diameter, plant fresh weight and plant dry weight. The highest number of branches/plant was recorded by the treatments SS 75% + leaf mould 25% and field soil 75% + leaf mould 25%. The treatment SS 50% + compost 50% resulted in highest number of leaves/plant and number of inflorescences/plant. The lowest values of all parameters was recorded by the treatment field soil 50% + leaf mould 50%. It can be concluded that 25% compost or leaf mould added to 75% field soil is a reasonable potting medium for bougainvillea.

Key Words: Bougainvillea sp., Potting media, Compost, Leaf mould, Growth, Flowering.

تأثير أوساط تعبئة مختلفة على نمو وإزهار نبات الجهنمية

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المستخلص

أجري هذا البحث في مشتل نباتات الزينة التابع لقسم البساتين – كلية الزراعة – جامعة الخرطوم في شمبات السنة 2015. كان الهدف إختبار تأثير خلط التربة السلتية (ت س) و تربة الحقل مع الكمبوست و الأوراق المتحللة (اضافات عضوية) بنسب مختلفه على نمو و إزهار نبات الجهنمية. زرعت شتلات الجهنمية في أكياس بلاستيك (40 سم قطر و 50 سم ارتفاع) محتوية على الأوساط التالية كمعاملات: ت س 100%، ت س 75% + كمبوست 25%، ت س 50% + كمبوست 50%، ت س 75%+ أوراق متحللة 25%، ت س 50% + أوراق متحلله 50%، تربة حقل 100%، تربة حقل 75% + كمبوست 25%، تربة حقل 50% + كمبوست 50%، تربة حقل 75% + أوراق متحلله 25%، تربة حقل 50% + أوراق متحلله 50%. رتبت المعاملات في تصميم قطاعات كاملة العشوائية بثلاث مكررات. مثلت الوحدة التجريبية بثلاثة نباتات.

جمعت بيانات حول ارتفاع النبات، عدد الأفرع بالنبات، عدد الأوراق بالنبات، سمك الساق، وزني االنبات الرطب والجاف وعدد النورات بالنبات. استجابة نبات الجهنمية للاضافات العضوية كانت أعلى في التربة السلتية (ت س) منها في تربة الحقل. المعاملة ت س 75% + كمبوست 25% سجلت أعلى قيم لارتفاع النبات، سمك الساق و وزني االنبات الرطب والجاف. المعاملتين ت س 75% + أوراق متحلله 25% و تربة حقل 75% + أوراق متحلله 25% نتج عنهما أعلى قيم لعدد الأفرع بالنبات. المعاملة ت س 50% + كمبوست 50% سجلت أعلى قيم لعدد الأوراق بالنبات و عدد النورات بالنبات. أدنى قيمة لكل المعايير سجلت بواسطة المعاملة تربة حقل 50%+ أوراق متحلله 50%. يمكن الختم بأن اضافة 25% كمبوست أو أوراق متحللة إلى 75% تربة حقل يعتبر وسط تعبئة مناسبا لنبات الجهنمية.

كلمات مفتاحية: الجهنمية، أوساط تعبئة، الكمبوست، أوراق متحللة، النمو، الإزهار.

Introduction

The genus bougainvillea has a wide variety of traits that made it excellent ornamental plant, a plant for environmental industries on account of large flexibility in different agro climatic regions of the world (Khandaker *et al,* 2015*;* Saifuddin *et al,* 2010*).* Bougainvillea has many uses as shrubs or bushes, ground cover, hedges, barriers, specimen plant (standards), in hanging baskets, in containers as potted flowering Plant and for bonsai (Kobayashi *et al*, 2007). Increasing awareness of environment-related issues, as well as the need to dispose of and use of rising amounts of waste along with the need to reduce the consumption of nonrenewable resources like peat have encouraged the use of composted organic biomass in agriculture. Growing media are the substrates in which a plant will grow. They greatly influence growth and development of plants in the nursery. They are an integral part of horticultural production systems. In nursery production industry, a variety of growing media are used worldwide.

Compost was reported to promote the physical and chemical properties of growing media. Maheswarappa *et al.* (1999) and Pandey and Shukla (2006) reported that the application of compost favorably affects soil pH, microbial population and soil enzyme activities. It improves soil structure, increase organic matter content, water holding capacity and reduces the frequency and

rate of irrigation (Azores-Hampton *et al*, 1998; Mitchell and Edwards, 1997; Liang *et al*, 2005). Compost is a good source to provide both macro - and micronutrients for plant growth. Courtney and Mullen (2008) found that nutritional elements such as potassium (K), calcium (Ca), magnesium (Mg), phosphorus (P), iron (Fe),copper (Cu) and manganese (Mn) increased, when compost was applied. Compost increases plant tolerance to soil salinity. Liang *et al.* (2005) reported that application of organic compost to soil improves physical and chemical characteristics of the soil, enhance tolerance of crops to salt stress by increasing drainage and soil water retention. The use of compost can reduce environmental pollution. Stofella and Graetz, (2000) stated that compost application reduces the proportion of water-soluble chemical species, which cause possible environmental contamination. Applications of chemical fertilizers have harmful effects on soil flora, fauna, and enzymes. This ultimately leads to decrease their activity for maintaining the natural fertility of soil (Gupta *et al*. 2014). In order to use soil nutrients more efficiently and to overcome pollution hazards the application of organic matter is gaining acceptance among farming communities (Riyaz, *et. al*. 2015). Leaf mould is formed from decaying leaves and produces an invaluable soil conditioner. Good quality, well decomposed leaf mould can be used as seed-sowing compost, or mixed equally with coarse sand, garden compost and good quality soil for use as potting compost (Anonymous, 2014). The positive effects of using composted organic biomass with growing media on vegetative growth and flowering of plants have been recorded by many research workers (Gupta *et al*. 2014 in marigold; Riyaz, *et. al*. 2008 in *Zinnia elegans*; Riyaz, *et. al*. 2015 in *Gerbera jamesonii*; Khayyat, *et. al.* 2007 in *Epipremnum aureum* and Kiran *et. al*. in *Dahlia pinnata*). Research on potting media for bougainvillea had not been carried out in Sudan and hence there is immense need for reliable research data regarding this field of research. The objective of this experiment was to study the effect of mixing silty soil/SS (Revarian sediments) and field soil with compost and leaf mould at different ratios on growth and flowering of *Bougainvillea* sp.

MATERIALS AND METHODS

This study was conducted at the Ornamental Plants Nursery of the Department of Horticulture, Faculty of agriculture, University of Khartoum at Shambat, (latitude 15 40 N, longitude 30 32 E), 280 inches above sea level, Khartoum state, during the period May-November. 2015. The potting mixes were prepared from silty soil/SS (Revarian sediments), field soil, compost, leaf mould and their combinations. The compost was brought form Socorro for organic fertilizers,

energy and environment services Co. LTD, Sudan. Leaf mould was prepared from partially decomposed mango leaves from the mango orchard of the Department of Horticulture. Rooted cuttings of *Bougainvillea* sp. about two months of age were used for this experiment. The media were potted in polyethylene bags with a dimension 40cm diameter and 50 cm height. The media were irrigated before transplanting the cuttings. After transplanting the bags were watered two times a week. A randomized complete block design was used; three plants represented an experimental unit, and each experimental unit was replicated three times. Statistical analysis was carried out using the SPSS program (version 20/ 2014); means were compared for significance by using Duncan's multiple range tests at 5% level of significance. Parameters measured were plant height, number of branches/plant, number of leaves/plant, stem diameter, plant fresh and dry weights and number of inflorescences/plant. Some properties (determined at the lab. of the Department of Soil and Environmental sciences, Faculty of Agriculture,University of Khartoum) of field soil are shown in table 1 and those of silty soil/SS (Revarian sediments), compost and leaf mould are shown in table 2. The ten treatments are shown in table 3.

Table 1: Field soil chemical and physical properties:

PH	ECe dS/m	Ca meq/l	Mg meq/l	Na meq/l	K meq/l	SAR	N %	P ppm	Sand %	Silt %	Clay %
7.5	1.9	1.8	3.7	14.4	0.75	9.0	0.09	10.0	17	20	63

Table 2: Some properties of Silty soil (SS), compost and leaf mould:

	PH	ECe dS/m	Ca meq/l	Mg meq/l	Na meq/l	K meq/l	SAR	N %	P ppm
Silty soil (SS)	7.8	1.1	2.1	5.8	1.8	0.26	1.0	0.04	6.0
Compost	6.7	2.4	17.0	21.0	84.6	105.0	19.0	0.30	34.0
Leaf mould	7.9	4.19	9.9	7.2	24.8	0.40	8.0	0.59	15.0

Table 3: Treatments:

Treatments	Composition
T_1	SS (100%)
T_2	SS 75% + compost 25%
T_3	SS 50% + compost 50%
T_4	SS 75% + leaf mould 25%
T_5	SS 50% + leaf mould 50%
T_6	Field Soil (100%)
T_7	Field Soil 75% + compost 25%
T_8	Field Soil 50% + compost 50%
T_9	Field Soil 75% + leaf mould 25%
T_{10}	Field Soil 50% + leaf mould 50%

RESULTS AND DISCUSSION

Growth medium is known to have a large effect on value of potted ornamental plants (Vendrame *et al.,* 2005). Both physical and chemical characteristics of the growth medium exert substantial effect on growth of plants. Among the physical characteristics, aeration and water holding capacity are probably the most important factors while, among the chemical characteristics, nutritional status, and salinity level have a crucial role on plant development (Dewayne *et al*., 2003).

Plant height: As shown in table 3, the treatments T2 (SS 75% + compost 25%), T3 (SS 50% + compost 50%) and T4 (SS 75% + leaf mould 25%) resulted in significantly higher plant height than T1 (SS 100%) with no significant differences between them. Although the difference between them was not significant, T5 (SS 50% + leaf mould 50%) also recorded higher value of plant height than T1 (SS 100%). The difference in plant height between T6 (Field soil 100%), T7 (Field soil 75% + compost 25%) and T8 (Field soil 50% + compost 50%) was not significant. The medium SS 75%+compost 25% recorded the highest value of plant height while the lowest value of plant height was recorded by T10 (Field soil 50% + leaf mould 50%). Several research workers observed increase in plant height using different organic amendments with potting media in different plants (Treder, 2008 in oriental lily 'star gazer'; Riaz *et al.,* 2015 in gerbera; Mehmood *et al.,* 2013 in *Antirrhinum majus* and Bashir *et al.,* 2007 in jojoba).

Number of branches/Plant: As shown in table 3, T4 (SS 75% + leaf mould 25%) and T9 (Field Soil 75% + leaf mould 25%) resulted in higher values compared to the rest of the treatments with

significant difference from only T1 (SS 100%) and T7 (Field soil 75% + compost 25%). These findings confirmed those of Bashir *et al.* (2007) who noted maximum number of shoots of *Sinmondsia chinensis* in Leaf mould-containing medium . Similar findings were also reported by Riaz *et al*., 2008 in *Zinnia elegans* cv. Blue Point having much increased side branches in coconut compost growing media in combination with silt + leaf manure.

Number of leaves/Plant: Table 3 demonstrates that all treatments of SS amendment with compost or leaf mould (T2, T3, T4, T5) differed non significantly with T1 (SS 100%) in terms of number of leaves per plant. However, all of them gave higher number of leaves per plant than T1 (silt 100%). This result is in agreement with that of Riyaz, *et. al*. (2008) in *Zinnia elegans* where SS amended with leaf manure and coconut compost differed non significantly with SS in terms of number of leaves per plant. The treatments of field soil T6 (field soil 100%) and field soil amended with compost or leaf mould (T7, T8, T9) differed non significantly among themselves with regard to number of leaves per plant. However, all of them differed significantly from T10 (field soil 50% + leaf mould 50%) which recorded the lowest value of leaves per plant. Such results might be attributed to natural fertility of field soil (table 3) and influence of environmental conditions on number of leaves (Riyaz, *et. al*. 2015).

Stem diameter: Plants exhibiting thick stem have more mechanical strength to resist breaking and bending against stress environmental conditions. Table 3 demonstrates that all treatments of SS amendment with compost or leaf mould (T2, T3, T4) except T5 (SS 50% + leaf mould 50%) resulted in significantly higher values of stem diameter than T1 (SS 100%) with no significant differences between them. In case of treatments of field soil amendment with compost or leaf mould only T7 and T8 resulted in significantly higher values of stem diameter than T6 (Field Soil 100%). This result is in agreement with that of Kiran *et al.* (2007) who observed thickest stem of dahlia (*Dahlia pinnata*) in sand + silt + leaf mould medium and Mehmood *et al.* (2013) who observed thickest stem in *Antirrhinum majus* using silt and top soil mixed with leaf mould or peat moss.

Plant fresh weight: As shown in table 4, all treatments of silt amendment with compost or leaf mould (T2, T3, T4) except T5 (SS 50% + leaf mould 50%) resulted in significantly higher fresh weight than T1 (SS 100%) with no significant differences between them. With regard to field soil amendment with compost or leaf mould all treatments except T8 (Field Soil 50% + compost 50%) differed non significantly among themselves. T8 resulted in significantly higher fresh weight than T9 (Field Soil 75% + leaf mould 25%) and T10 (Field Soil 50% + leaf mould 50%).

Plant dry weight: Table 4 demonstrated significant differences among treatments. All treatments of SS amendment with compost or leaf mould (T2, T3, T4) except T5 (SS 50% + leaf mould 50%) resulted in significantly higher dry weight than T1 (SS 100%) with no significant differences between them. Regarding field soil amendment with compost or leaf mould all treatments except T10 (Field Soil 50% + leaf mould 50%) which recorded the lowest dry weight, differed non significantly from T6 (Field Soil 100%). Increase of plant fresh and weights using organic amendments with potting media was reported by several research workers. Wang and Konow (1999) observed highest increase in fresh weight of Moth Orchid in peat comprising medium than any other media. Mehmood *et al.* (2013) observed highest fresh and dry weights in *Antirrhinum majus* using leaf mould and peat moss amendments. Similar results were observed for *Epipremum aureum* by Khayyat (2007).

Number of inflorescences/plant: As shown in table 5 all treatments of SS amendment with compost or leaf mould resulted in significantly higher number of inflorescences/plant than T1 (SS 100%). Similar results were reported by Riyaz, *et. al*. (2015) who found highest number of flowers in gerbera in a medium of silt + compost. Regarding field soil amendment with compost or leaf mould all treatments except T10 (Field Soil 50% + leaf mould 50%) which recorded the lowest number of inflorescences/plant, differed non significantly from T6 (Field Soil 100%). Such results might be attributed to natural fertility of field soil (table 3). Nowak and Strojny (2004) observed that optimum amount of P in organic residues provide maximum increase in flowering of gerbera. Treder (2008) reported that oriental lily 'star gazer' plants had long stem, and maximum flowering in growing media with optimum P and K contents. It is worth mentioning that the compost used in this research was rich in P and K (table 1). The low values of most parameters (Tables 3, 4, 5) recorded by T1 (SS 100%) might be due to its high pH (table 1). Proper soil pH is essential because it affects the availability of mineral elements. Bougainvillea does best with a slightly acidic soil having a pH of 5.5-6.0 (Kobayashi *et a*l, 2007). High percentage of leaf mould in the medium especially with field soil in T10 (Field Soil 50% + leaf mould 50%) resulted in lowest values of most parameters (Tables 3, 4, 5). This might be due to increase in water retention with increase in leaf mould content in the medium. To some extent the same applies for the treatment (SS 50% + leaf mould 50%) which resulted in relatively lower values of most parameters among the treatments of SS amendment with compost or leaf mould. Bougainvillea is characterized by an extremely fine root system, and should be planted in well-drained soils. Soil mixes with high peat levels and water retention should be avoided (Kobayashi *et a*l, 2007). Substrates having higher EC affect plant

growth (Miller, 2001). High salinity (EC) in leaf mould (table 1) might also be a reason of lower values obtained.

Conclusion: Since organic amendments and SS are to some extent expensive, it can be stated that 25% compost or leaf mould added to 75% field soil is a reasonable potting medium for bougainvillea.

Table 3. Effect of different potting media on growth parameters of bougainvillea (*Bougainvillea* sp.) twenty four weeks after transplanting.

Potting media	Plant height (cm)	Number of branches/plant	Number of leaves per plant	Stem diameter (mm)
T1 (SS 100%)	56.4^{de}	6.4^{b}	239^{a}	7.3^{cd}
T2 (SS 75% + compost 25%)	101.8^{a}	9.9^{ab}	327^{a}	9.9^{a}
T3 (SS 50% + compost 50%)	87.3^{abc}	10.8^{ab}	385.9^{a}	9.9^{a}
T4 (SS 75% + leaf mould 25%)	95.2^{ab}	15.2^{a}	364.9^{a}	9.5^{ab}
T5 (SS 50% + leaf mould 50%)	67.9^{bcd}	9.7^{ab}	285.1^{a}	7.9^{bc}
T6 (Field soil 100%)	84.8^{abcd}	9.4^{ab}	277.6^{a}	8^{bc}
T7 (Field soil 75% + compost 25%)	74.9^{abcd}	6.7^{b}	243^{a}	9.5^{ab}
T8 (Field soil 50% + compost 50%)	91.3^{ab}	8.4^{ab}	268.1^{a}	9.6^{ab}
T9 (Field soil 75% + leaf mould 25%)	58.9^{cde}	15.3^{a}	364.8^{a}	7.2^{cd}
T10 (Field soil 50% + leaf mould 50%)	34^{e}	10.3^{ab}	101.8^{b}	5.6^{d}

Means followed by the same letter "s" in the same column are not significantly different (P = 0.05) according to Duncan's Multiple Range Test.

Table 4. Effect of different potting media on growth parameters (Plant fresh and dry weights) of bougainvillea (*Bougainvillea* sp.) twenty four weeks after transplanting.

Potting media	Plant fresh weight (gm)	Plant dry weight (gm)
T1 (SS 100%)	53.5^{c}	25.5^{cd}
T2 (SS 75% + compost 25%)	146.6^{a}	60.4^{ab}
T3 (SS 50% + compost 50%)	135.7^{a}	63.6^{a}
T4 (SS 75% + leaf mould 25%)	118^{ab}	58.6^{ab}
T5 (SS 50% + leaf mould 50%)	84.2^{abc}	35.6^{bcd}
T6 (Field soil 100%)	83.3^{abc}	41.9^{abc}
T7 (Field soil 75% + compost 25%)	93.2^{abc}	38.4^{bcd}
T8 (Field soil 50% + compost 50%)	125.3^{a}	58.7^{ab}
T9 (Field soil 75% + leaf mould 25%)	62.2^{bc}	26.6^{cd}
T10 (Field soil 50% + leaf mould 50%)	32.7^{c}	15.1^{d}

Means followed by the same letter "s" in the same column are not significantly different (P = 0.05) according to Duncan's Multiple Range Test.

Table 5. Effect of different potting media on number of inflorescences/plant of bougainvillea (*Bougainvillea* sp.) twenty weeks after transplanting.

potting media	Number of inflorescences/plant
T1 (SS 100%)	86^{d}
T2 (SS 75% + compost 25%)	154.3^{bc}
T3 (SS 50% + compost 50%)	234^{a}
T4 (SS 75% + leaf mould 25%)	198.3^{ab}
T5 (SS 50% + leaf mould 50%)	152.7^{bc}
T6 (Field Soil 100%)	126.1^{cd}
T7 (Field Soil 75% + compost 25%)	177.4^{abc}
T8 (Field Soil 50% + compost 50%)	173.9^{abc}
T9 (Field Soil 75% + leaf mould 25%)	80.9^{de}
T10 (Field Soil 50% + leaf mould 50%)	19.6^{e}

Means followed by the same letter "s" in the same column are not significantly different (P = 0.05) according to Duncan's Multiple Range Test.

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