academicJournals

Vol. 10(7), pp. 596-603, 12 February, 2015
DOI: 10.5897/AJAR2014.8490
Article Number: 485980950328
ISSN 1991-637X

http://www.academicjournals.org/AJAR

African Journal of Agricultural Research

*Full Length Research Paper*

# Compost of garbage and tree pruning used as substrates for production of irrigated wild poinsettia seedling

**Bárbara Barofaldi Ariguchi[1], João Antonio Galbiatti[2], Aline Rombega Tito Rosa[1], Flávia Gomes da Silva[1] and Rogério Teixeira de Faria[2]***

[1]Centro Universitário UNIFAFIBE, Bebedouro, SP, Brazil.
[2]FCAV-Unesp,-Univ Estadual Paulista, Jaboticabal, Sp, Brazil.

Received 9 January, 2014; Accepted 22 January, 2015

**The high nutrient content in organic composted waste is an alternative source of fertilizer for use in agriculture and for re-establishment of native forests. This work had as an objective is aimed to evaluate the growth of *Pterogyne nitens* (wild poinsettia) seedlings, a rainforest native species, on substrates containing composts of organic garbage and tree pruning. A greenhouse experiment was conducted, in which seedlings were randomly transplanted into tubes to establish 8 treatments, 4 substrates and 2 irrigation depths, in a 4×2 factorial arrangement, with three replicates. The substrates were: S1: 80% tree pruning compost and 20% garbage compost; S2: 100% tree pruning compost; S3: 80% tree pruning compost and 20% commercial substrate; S4: 100% commercial substrate. Irrigation was applied to supply 50% (Depth 1) and 100% (Depth 2) of daily reference evapotranspiration. Plantlet growth was not affected by irrigation, but plantlets were significantly taller in the treatment with 80% tree pruning plus 20% garbage composts. It was concluded that seedling formation of wild Poinsettia in a greenhouse environment can be satisfactorily obtained by supplying half of daily reference evapotranspiration depth and a substrate consisting of 80% pruning tree plus 20% garbage composts, which is suitable to replace the commercial fertilizer product.**

**Key words:** Growing media, organic compost, re-establishment native plants.

## INTRODUCTION

According to the Brazilian Association of Special Waste and Public Cleaning (ABRELPE 2010), the country generated more than 57 million tons of solid waste in 2009, corresponding to growth of 7.7% over the previous year's volume. In this context, attitudes seeking for alternatives to minimize the volume of waste disposed are essential to mitigate the environmental problem (IBGE, 2010). The main society's challenge is to ensure access and sustainable for use of natural resources (Pigatim, 2011), because population growth leads to greater consumption of food and non-durable goods, increasing considerably the production of waste.

The public forestation generates a significant amount of green waste, because of the pruning and subsequent

*Corresponding author. E-mail: rogeriofaria@fcav.unesp.br

removals made. That waste end up in landfills and, in some cases, are burned in open disposal areas.

Organic agriculture has been used as a strategy for soil management in an attempt to achieve a sustainable agriculture (Goedert and Oliveira, 2007), using designed processes to mitigate the sharp increase in production of organic solid waste. Among the processes, the composting has been shown as an interesting alternative, since it has the ability to reduce volume and mass of organic waste by approximately 50%, and generate a stable product, which can be beneficial for agriculture (Raviv, 2011).

Sewage sludge, organic waste, tree pruning, garbage, orange bagasse and animal manure have been used as organic amendments in food production, with a great success when processed by composting (Fialho et al., 2010; Torri et al., 2012; De Lucia et al., 2013a), reducing input by mineral fertilizers, increasing crop productivity and avoiding improper disposal, which leads to less pollution of soil and groundwater.

The composting process aims to accelerate decomposition of organic material under optimal conditions for microbial growth. Basically, temperature, aeration, moisture, carbon, nitrogen and nutrients are the factors that interfere with the composting process (Ausina et al., 2000). In that sense, many reports have showed domestic organic waste as important source of nutrients for plant growth (Nóbrega et al., 2008; Fialho et al., 2010).

In literature, there are many reports on organic fertilizer increasing accumulation of nutrients and vigor of tree seedlings, allowing better growth after transplantation (Nóbrega et al., 2008; Stellacci et al., 2013). However, there are few studies on evaluating organic compound concentrations compost rates as substrate for development of tree seedlings (Ferrini and Nicese, 2005; Bakry et al., 2013; De Lucia et al., 2013b).

The application of urban waste compost in agriculture is advantageous due to its high organic matter and nutrients contents, absence of pathogenic microorganisms and provided benefits on conditions of cultivation (increase in organic matter content, high pH value and availability of phosphorus, potassium, calcium and magnesium), nutritional and production of plants (Mantovani et al., 2005). The use of urban waste compounds as conditioning of agricultural soils is a usual practice in many countries, because it provides high levels of organic matter and nutrients to plant, such as nitrogen and phosphorus. According to Franco et al. (2010), those are the most important minerals for plant tillering. Mantovani et al. (2006) recognized a high potential of waste compost as nitrogen source for agriculture, but pointed as a constraint its slow release by mineralization.

The frequent application of compost can increase pH (Russo et al., 2009; Krob et al., 2011), however, any benefit will depend on its composition, time of application and amount applied. Ruppentahl and Castro (2005) found adequate nutrition of gladiolus using compost in a quantity of 10 t $ha^{-1}$. Mancini and De Lucia (2011) also reported increased plant spike of gladiolus plants receiving urban sludge based compost. Oliveira Junior (2008) studied the response of application of urban waste compost, horse and cattle manure with subsoil constituents as a substrate for the production

of *Pterogyne nitens* seedlings. In that research, better results were obtained by applying substrates containing 75% waste compost, 50% waste compost plus 25% horse manure and 25% waste compost plus 50% horse manure. Evaluating application of waste compost and tree pruning as a substrate, concluded as the best treatment the application 20% waste compost with 80% of tree pruning. Nóbrega et al. (2008) evaluated the effect of urban waste compost on seedlings growth of *Enterolobium contortisiliquum* (Vell.) (monkey-ear). They found improved soil fertility as a result of increased pH and also higher concentrations of P, K, Ca, Mg, organic matter and micro-nutrient, which gave thicker stem diameter, taller plant and higher dry matter. According to Nóbrega et al. (2008), the mix 80% waste compost plus 20% soil without liming was the best substrate for production of *E. contortisiliquum*.

Waste compost dose need to be evaluated for each plant species, in order to assess crop yield response and to prevent contamination by heavy metals. Evaluations of increasing waste dosage by Nobile et al. (2007) showed negative crop growth effects for substrates with concentrations above 30% of urban waste compost. Better growth of native species was found using organic waste compound as substrate, particularly for *Schizolobium parahyba* (Vell.) Blake. (guapuruvu) (Sabonaro, 2006), but not for *Tabebuia impetiginosa* (Mart.) Standl (ipe-purple) (Sabonaro and Galbiatti, 2007).

Several studies showed benefits of organic matter to improve soil physical properties and consequent positive impacts on crop yield (De Lucia et al., 2013c). Organic matter is of great importance as a source of nutrients to plants, in soil cation retention and to improve or maintain soil structure, increasing infiltration and water retention, microbial activity and other properties (Pelá 2005). Increasing soil organic matter content by application of organic waste is beneficial to soil physics and to maintain a good soil structure (Silva et al., 2002).

There a distinct effect of pH on nutrient availability in organic substrate as compared to mineral soil (Ostos et al., 2008). Stabilized organic compost is a product of a controlled process involving biochemical decomposition of organic material to a more stable product, used as a fertilizer, with pH above 6.5 and C/N ratio below 1.8, due to the soil immobilization of N. The dose should be less than the maximum total N (305 kg $ha^{-1}$) to avoid risk of contamination by $NO_3$ leaching through the soil profile (Oliveira et al., 2001). Therefore, N, $P_2O_5$ and $K_20$ soil contents have to be known before defining dose for application of organic compost. Water is of major importance for seedling development, since it is involved in several plant metabolic processes. Irrigation has to be applied properly to provide adequate water supply at the appropriate time for achieving best plant growth and development. While water stress decrease plant growth and nutrient uptake, water excess may promote nutrient leaching and can even provide a favorable microclimate to development of diseases, in addition to socio-environmental issues relating to water saving and the accumulation of leachate in the soil (Lopes, 2005).

The type of substrate used in the seedling production is crucial in determining irrigation frequency and volume of water to be applied (Wendling and Gatto, 2002). Irrigation in small containers such as tubes used for seedling growth has to be applied in a high frequency. Substrates with low water retention capacity, such as carbonized rice, sand, chaff charcoal, require more frequent irrigation, as compared to substrates with higher water retention capacity, such as subsurface soil, compost, humus, coconut fiber etc., in order to achieve uniform water distribution in the substrate and prevent buildup of salts. The risks of diseases in plants are reduced when water is applied in the morning, because it prevents high moisture in the substrate in the evening.

*Pterogyne nitens* Tul., widely known as 'wild poinsettia', is a specie of the family Leguminosae – Caesalpinoideae, which occurs from the Northern through Southern Brazil. It is a deciduous plant, heliophille, semidecidous, typical of broadleaf forest, blooming from December to March and ripening from May to July (Carvalho, 2003). It is an ornamental tree of a high monetary value, suitable for afforestation of urban roads and highways. Wild poinsettia has great economic and environmental potential; his wood is elastic, tough and durable, suitable for fine furniture, general carpentry, construction, manufacture of casks, barrels and tanks for beverages and acids. Due to its hardiness and fast growth, is used for mixed plantations in degraded areas of permanent preservation (Lorenzi, 2000). Its timber has characteristics of resilient, tenacious and resistant, which makes it suitable for fine furniture, general carpentry and construction. It is also considered as an ornamental tree with high economic value, recommended also for afforestation of street and roads, replacement of riparian forest in areas with flooding and revegetation in sandy and degraded soils (Ausina et al., 1994).

Therefore, the objective of this study was to compare growth of Pterogyne *nitens* seedlings (wild groundnut) on commercial substrates and substrates containing garbage and pruning trees composts, submitted to two irrigation levels, in a greenhouse.

## MATERIALS AND METHODS

The experiment was conducted from May to August 2010 in the Department of Rural Engineering of the Faculdade de Ciências Arárias e Veterinárias, Câmpus de Jaboticabal, Universidade Estadual Paulista (FCAV-UNESP), Brazil. The site is located at latitude 21º 15' 15'' S, longitude 48º 18' 09'' W and altitude around 595 m. The climate classification is Tropical wet and dry or savanna climate (Aw), according to Köppen, characterized by a subtropical climate, with hot summer and dry winter. Average temperature is about 21ºC, minimum temperature (average value about 12.5ºC) occurs on June and July, and higher temperature (average value about 30.6ºC) occurs during December to February. Mean annual precipitation value is about 1,400 mm, with 80% occurring from October to March).

The experiment was conducted in a greenhouse, covered by a plastic dark net with 50% light interception and closed on the sides by an antiaphid net. Eight treatments were arranged in a randomly experimental design, following a 4 × 2 (4 substrates by 2 irrigation levels) factorial scheme with 3 replicates. The results were submitted to an analysis of variance (ANOVA), by testing significance by the F test, and comparing means by the Tukey test at 5% probability.

The volumetric proportion of substrates row materials characteristics of the substrates used for the constitution of four compared substrates are given in Table 1.

Irrigation was applied daily manually in two levels: 50% (level 1) and 100% (level 2) of daily reference evapotranspiration estimated by an atmometer (Broner and Law, 1991). The cumulative depths of applied water for each irrigation level are presented in Table 2.

The tree pruning compost used in this research was obtained in the county of Guaíra, SP, from street pruning, after crushing the twigs and leaves for the composting process. The material was collected at random from piles previously composted, and then transported to the Laboratory of the Department of Rural Engineering of FCAV-UNESP- Jaboticabal, for final screening (mesh 5 mm). Physical and chemical analyses were performed according to the methodology of the National Reference Laboratory for Plant (1998) in the laboratory of ESALQ / USP. The same analyses were performed for the garbage compost, which was obtained from composting of organic waste collected in the county of Sao Jose do Rio Preto, SP.

The seeds for production of wild poinsettia seedlings were collected in the field of Unesp Campus, in Jaboticabal, SP, in addition to seeds collected in the rural settlement Reage Brasil of ITESP, in County of Bebedouro, SP.

Seedlings were transplanted in rigid plastic tubes (13 cm height and 160 cm³ volume) containing the different substrates (Table 1). A polypropylene net was used as support, after mixing the substrate components by hand. The chemical and physical characteristics of the substrates row materials are given in Table 3.

In each tube, two seeds of *Ptegyne nitens* were sown to leave one plantlet after thinning at 30 days of emergence. The following evaluation parameters were taken on seedling growth: (a) Plantlet height (cm), by measuring plantlet height from the surface of the substrate to the inflection of the top leaf fully expanded using a ruler graduated in millimeters; (b) stem diameter (mm), using digital caliper measuring at 2 cm of substrate surface; (c) leaves (n), counting the number of leaves, and d) plantlet dry weight (g/plant), weighing on a precision scale after drying at 70°C in an oven of forced air. Measurements a, b and c were measured every 15 days and d at the end of the experiment. No fertilizer was applied on those substrates.

## RESULTS AND DISCUSSION

The analysis of variance of treatment main effects on wild poinsettia plantlets growth showed significance for

**Table 1.** Volumetric proportion of substrates row materials (%) used for the constitution of four compared substrates.

| Substrate | Tree pruning compost | Garbage compost | Commercial substrate |
|---|---|---|---|
| S1 | 80 | 20 | 0 |
| S2 | 100 | 0 | 0 |
| S3 | 80 | 0 | 20 |
| S4 | 0 | 0 | 100 |

**Table 2.** Irrigation depths (mm) according to irrigation treatments.

| Irrigation depth | Month | | | | Total |
|---|---|---|---|---|---|
| | May | June | July | August | |
| 100 ETo | 86 | 88 | 84 | 119 | 377 |
| 50 ETo | 43 | 44 | 42 | 59 | 188 |

**Table 3**. Chemical and physical characteristics of substrates row materials used for seedlings production of wild poinsettia.

| Characteristics | Commercial substrate | Garbage compost | Tree pruning compost |
|---|---|---|---|
| pH in $CaCl_2$ 0,01 M | 5.2 | 7.8 | 7.1 |
| Density (g $m^{-3}$) | 0.64 | 0.58 | 0.68 |
| Total C (organic and mineral %) | 32 | 25 | 25 |
| Total N (%) | 1.00 | 0.72 | 2.11 |
| Total P ($P_20_5$%) | 0.12 | 0.72 | 0.41 |
| Total K ($K_2O$%) | 0.31 | 0.45 | 1.74 |
| Total Ca (%) | 2.59 | 5.04 | 4.00 |
| Total Mg (%) | 1.26 | 0.32 | 0.39 |
| Total S (%) | 0.16 | 0.28 | 0.33 |
| Total B (mg $kg^{-1}$) | 4 | 8 | 11 |
| Total Cu (mg $kg^{-1}$) | 29 | 437 | 61 |
| Total Fe (mg $kg^{-1}$) | 17423 | 18833 | 41918 |
| Total Mn (mg $kg^{-1}$) | 202 | 455 | 444 |
| Total Zn (mg $kg^{-1}$) | 47 | 519 | 87 |
| Total Mn (%) | 1,26 | 0,27 | 0,39 |
| C/N ratio ( Total C : total N) | 32 | 15 | 12 |
| C/N ratio (Organic C : Total N) | 32 | 14 | 12 |

Source: Laboratory of Soils of ESALQ-USP, Piracicaba, SP.

subtract type and no significance for irrigation level, according to the F test (Table 4). The interaction of irrigation level to substrate type had no significance, except for stem diameter (Figure 1).

The comparison of means for substrate treatments showed the substrate containing tree pruning and garbage composts in a proportion 4:1 the most effective in developing wild poinsettia seedlings, for all growth variables, except for number of leaflets, in which compost containing 100% pruning showed similar result as the treatment 4:1 tree pruning / garbage composts (Table 4 and Figure 2).

For the treatment 4:1 tree pruning / garbage composts, the results of plantlet height and number of leaflets per plantlet were adjusted to a second-degree polynomial regression, while stem diameter data were adjusted to an exponential curve (Figures 3 to 5).

Those results can be attributed to the capability of that substrate to sustain plantlets, which are essential for production of high quality tree seedlings, besides providing nutrients and increase water retention without compromising root aeration. Another important advantage

**Table 4.** Analysis of variance (ANOVA) of main effects of treatments on growth variables of *wild poinsettia*, comparison of means (MEANS) and coefficient of variation (CV%).

| Factor | Plant height (cm) | Stem diameter (mm) | Leaflet (n) | Plant dry weight (g plant$^{-1}$) |
|---|---|---|---|---|
| **Substrate (S)** | | | | |
| Tree pruning/garbage compost (4:1) | 6.02$^{a}$ | 1.60$^{a}$ | 10.50$^{a}$ | 0.48$^{a}$ |
| Commercial | 4.56$^{b}$ | 1.30$^{b}$ | 6.37$^{b}$ | 0.26$^{b}$ |
| Tree pruning | 5.03$^{b}$ | 1.41$^{b}$ | 9.93$^{a}$ | 0.28$^{b}$ |
| Commercial/tree pruning (1:4) | 4.87$^{b}$ | 1.37$^{b}$ | 6.67$^{b}$ | 0.25$^{b}$ |
| **Irrigation depth (I)** | | | | |
| 50% | 5.47$^{a}$ | 1.41$^{a}$ | 8.58$^{a}$ | 0.31$^{a}$ |
| 100% | 5.42$^{a}$ | 1.45$^{a}$ | 8.21$^{a}$ | 0.32$^{a}$ |
| **ANOVA** | | | | |
| Substrates (S) | 10.29** | 19.44** | 11.95** | 24.88** |
| Irrigation depth (I) | 0.24$^{ns}$ | 2.82$^{ns}$ | 2.02$^{ns}$ | 0.15$^{ns}$ |
| S x I | 1.25$^{ns}$ | 4.32* | 0.82$^{ns}$ | 2.08$^{ns}$ |

**; * and $^{ns}$, significant at 1%; 5% and non significant at 5% by F test, respectively. Means followed by different characters on columns are different by Tukey test (5%).

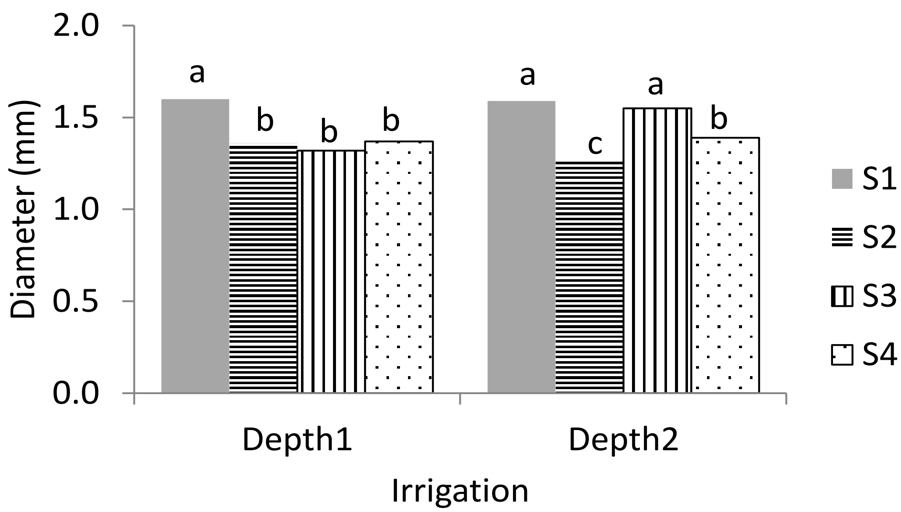


**Figure 1.** Histogram of stem diameter for the interaction substrate an irrigation depth. Substrate S1 is tree pruning/garbage compost (4:1), S2 is commercial, S3 is tree pruning, S4 is commercial/tree pruning (1:4), and depth 1 is 50% and depth 2 is100% of daily reference evapotranspiration. Means followed by different characters above the columns are different by Tukey test (5%).

was the low C/N ratio (<25) of substrate containing high portion of pruning of tree, because of faster mineralization of organic matter, increasing nutrients availability to plants (Malavolta, 2006). The chemical composition of the pruning compost used in this study (Table 3) was higher in nitrogen and potassium, as compared to other studies. The treatment with commercial subtract was supplanted by 4:1 tree pruning / garbage composts because of its beneficial effects, according Nóbrega et al. (2008), including capability to increase pH and the concentration of P, K, Ca, Mg, organic matter and micronutrient, improving soil fertility.

## Conclusions

The substrate containing 4:1 tree pruning / g arbage composts provide the best results for growth of wild

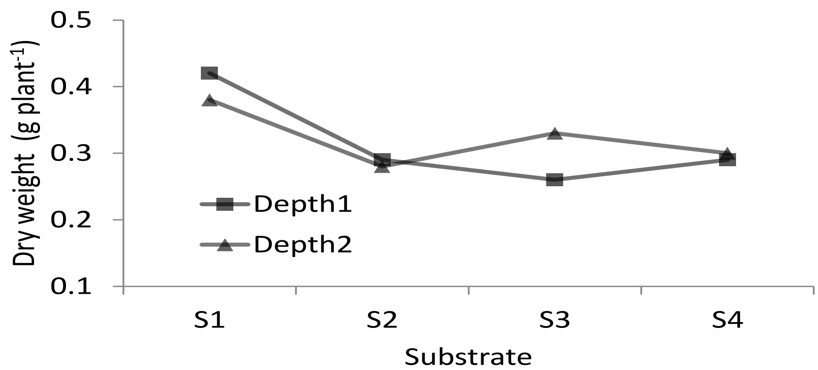


**Figure 2.** Plantlet dry weight as a function of substrate and irrigation depth. Substrate S1 is tree pruning/Garbage compost (4:1), S2 is commercial, S3 is tree pruning, S4 is commercial/tree pruning (1:4), and depth 1 is 50% and depth 2 is100% of daily reference evapotranspiration.

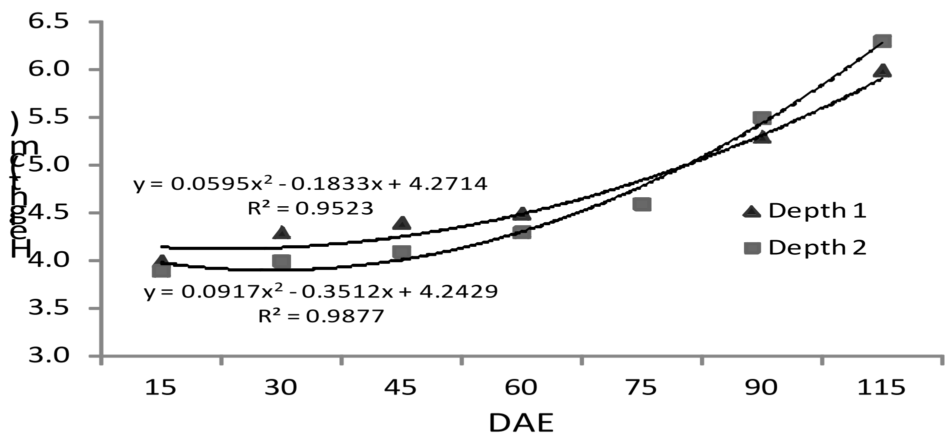


**Figure 3.** Plantlet height as a function of days after emergence (DAE) for the treatment 4:1 tree pruning/garbage composts (80% tree pruning and 20% garbage composts) under two irrigation depths (Depth 1 is 50% and depth 2 is 100% of daily reference evapotranspiration).

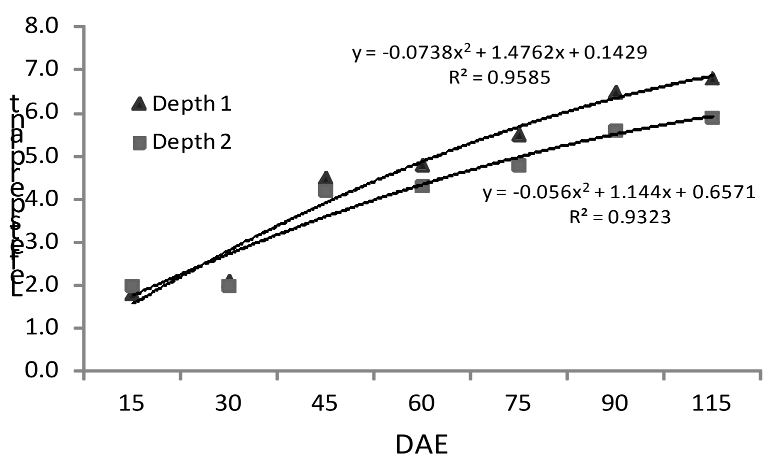


**Figure 4.** Number of leaflets per plantlet as a function of days after emergence (DAE) for the treatment 4:1 tree pruning/garbage composts (80% tree pruning and 20% garbage composts) under two irrigation depths (Depth 1 is 50% and Depth 2 is100% of daily reference evapotranspiration).

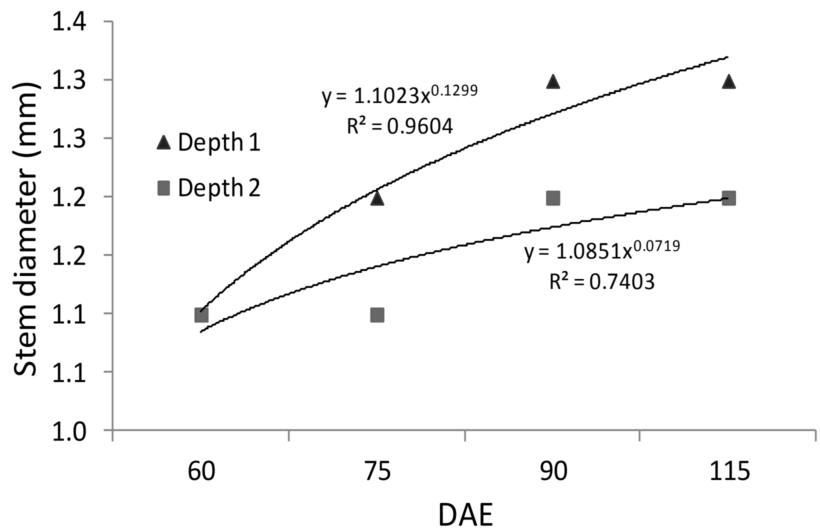


**Figure 5.** Stem diameter as a function of days after emergence (DAE) for the treatment 4:1 tree pruning/garbage composts (80% tree pruning and 20% garbage composts) under two irrigation depths (Depth 1 is 50% and Depth 2 is 100% of daily reference evapotranspiration).

poinsettia being appropriate to replace the commercial substrate. The effects of the treatment 4:1 tree pruning / garbage composts on plantlet height and leaflet number adjust to a second degree polynomial curve, while stem diameter follow an exponential response. Irrigation supplying half of daily reference evapotranspiration is sufficient for plantlet formation of wild poinsettia in greenhouse.

## Conflict of Interest

The authors have not declared any conflict of interest.

## REFERENCES


ABRELPE Associação Brasileira de Empresas de Limpeza Pública e Resíduos Especiais (2010). Brasil Registrou aumento considerável na geração de resíduos sólidos urbanos. *Artigo*. 2010. Disponível em http://www.abrelpe.org.br/noticias_releases.php?codeps=MzQ= Acesso em 05/07/2011.

Ausina MC, Matos AT, Sediuama MAN, Costa LM (2000). Dinâmica da decomposição de resíduos orgânicos. In: CONGRESSO BRASILEIRO DE ENGENHARIA AGRÍCOLA. Fortaleza. Anais... Fortaleza: Soc. Bras. Engenharia Agríc. P. 29

Bakry M, Lamhamedi MS, Caron J, Bernier PY, El Abidine AZ, Stowe DC, Margolis HA (2013). Changes in the physical properties of two Acacia compost-based growing media and their effects on carob (*Ceratonia siliqua* L.) seedling development. New For. 44(6):827-847.

Broner I, Law RAP (1991). Evaluation of modified atmometer for estimating reference ET. Irrig. Sci. 12(1):21-26.

Carvalho PER (1994). Espécies florestais brasileiras: Recomendações silviculturais, potencialidades e uso da madeira. Embrapa, Piracicaba P. 45.

Carvalho PER (2003). Espécies arbóreas brasileiras. 1. ed. Brasília: Embrapa Inform. Tecnol. 1:1039.

De Lucia B, Cristiano G, Vecchietti L, Rea E, Russo G (2013a). Nursery Growing Media: Agronomic and Environmental Quality Assessment of Sewage Sludge-Based Compost. Appl. Environ. Soil Sci. P. 10. doi:10.1155/2013/565139

De Lucia B, Vecchietti L, Rinaldi S, Rivera CM, Trinchera A, Rea E (2013b). Effect of peat-reduced and peat-free substrates on *Rosmarinus officinalis* L. growth. J. Plant Nutr. 36(6):863-876.

De Lucia B, Cristiano G, Vecchietti L, Bruno L (2013c). Effect of different rates of composted organic amendement on urban soil properties. growth and nutrient status of three Mediterranean native hedge species. Urban For. Urban Green. 12(4):537-545.

Ferrini F, Nicese FP (2005). Effect of compost-based substrates on growth and leaf physiology of Acer campestre and Cornus alba potted plants. Adv. Hortic. Sci. 19(2):76-80.

Fialho LL, Silva WTL, Milori MBP, Simões ML, Martin-Neto L (2010). Characterization of organic matter from composting of different residues by physicochemical and spectroscopic methods. Bioresour. Technol. 101(6):1927-1934.

Franco HCJ, Trivelini PCO, Faroni CE, Vitti AC, Otto R (2010). Stalk yield and technological attributes of planted cane as related to nitrogen fertilization. Sci. Agric. 67(5):579-590.

Goedert WJ, Oliveira SA (2007). Fertilidade do solo e sustentabilidade da atividade agrícola. In: Novais R F. Alvarez VH. Barros NF. Fontes RLF. Cantarutti RB. Neves JC. Sociedade brasileira de ciência do solo. fertilidade do solo. Viçosa: Novais R. F. P. 994.

IBGE (Instituto Brasileiro de Geografia e Estatística) (2010). Indicadores de Desenvolvimento Sustentável – Brasil 2010. Estudos & Pesquisas – Informação Geográfica. Digital – Disponível em: www.ibge.gov.br/home/geociencias/recursosnaturais/ids/ids2010.pdf. 7:443.

Krob AD, Moraes SP, Selbach PA, Bento FM, Camargo FAQ (2011). Propriedades químicas de um Argissolo tratado sucessivamente com composto de lixo urbano. Cienc. Rural 41(3):433-439.

Lopes JLW (2005). Efeitos na irrigação na sobrevivência. transpiração e no teor relativo de água na folha em mudas de *Eucalyptus grandis* em diferentes substratos. Sci For. 1(68):1097-1006.

Lorenzi H (2000). Árvores brasileiras: Manual de identificação e cultivo de plantas arbóreas nativas do Brasil. Nova Odessa: Editora Plantarum.

Malavolta E (2006). Manual de nutrição mineral de plantas. Piracicaba: Agronômica Ceres. 631 pp.

Mancini L, De Lucia B (2011). Organic and mineral soil fertilization in Gladiolus. Compost. Sci. Util. 19(3):178-181.

Mantovani JR, Ferreira ME, Cruz MCP, Barbosa JC, Ferreira AC (2006). Mineralização de carbono e de nitrogênio provenientes do composto de lixo urbano em argissolo. Rev. Bras. Cienc. Solo 30(4):677-684.

Mantovani JR, Ferreira ME, Cruz MCP (2005). Alterações nos atributos de fertilidade do solo adubado com composto de lixo urbano. Rev. Bras. Cienc. Solo. 29(5):817-824.

Nobile FO, Galbiatti JÁ, Muraishi RI, Cordido JPBR, Andrião MA (2007) Doses de composto de lixo no substrato e dois níveis de irrigação em crisântemo. In: Associação Brasileira de Engenharia Agrícola. Congresso Brasileiro de Engenharia Agrícola. 37. 2007. Bonito. Anais... Jaboticabal:. 1 CD-ROM.

Nóbrega RSA, Ferreira PAA, Santos JGD, Vilas Boas RC, Nóbrega JCA, Moreira FMS (2008). Efeito composto de lixo urbano e calagem no crescimento inicial de mudas de *Enterolobium contortisiliquum (Veell.) Morong.* Sci For. 36(79):181-189.

Oliveira Jr AG (2008). Utilização de compostos de lixo urbano como substrato para a produção de mudas de espécies arbóreas. [Monographi]. Seropédica: Universidade Federal Rural do Rio de Janeiro.

Oliveira FC, Mattiazzo ME, Marciano CR, Moraes SO (2001). Percolação de nitrato em latossolo amarelo distrófico afetado pela aplicação de composto de lixo urbano e adubação mineral. Rev. Bras. Cienc. Solo 25(3):731-741.

Ostos JC. López-Garrido R, Murillo JM, López R (2008). Substitution of peat for municipal solid waste-and sewage sludge-based composts in nursery growing media: Effects on growth and nutrition of the native shrub "*Pistacia lentiscus*" L. Bioresour. Technol. 99(6):1793-1800.

Pelá A (2005). Efeito de adubos orgânicos provenientes de dejetos bovinos confinados nos atributos físicos e químicos do solo e na produtividade do milho [PhD Thesis]. Botucatu: Universidade Estadual Paulista. Faculdade de Ciências Agronômicas .

Raviv M (2011). The future of compost as ingredients of growing media. Acta Hort. 891:19-32.

Ruppenthal V Castro AMC (2005). Efeito do composto de lixo urbano na nutrição e produção de gladíolo. Rev. Bras. Ciênc. Solo 29(1):145-150.

Russo G, De Lucia B, Vecchietti L, Rea E, Leone A (2009). Environmental and agronomical analysis of different compost-based peat-free substrates in potted rosemary. Acta Hort. 891:265-272.

Sabonaro DZ (2006). Utilização de composto de lixo urbano na produção de mudas de espécies arbóreas nativas com dois níveis de irrigação [Master Thesis]. Jaboticabal: Faculdade de Ciências Agrárias e Veterinárias. Universidade Estadual Paulista.

Sabonaro DZ, Galbiatti JA (2007). Efeito de níveis de irrigação em substratos para a produção de mudas de ipê-roxo. Sci. For. 74(1):95-102.

Silva FC, Berton RS, Chitolina JC, Ballestero SD (2002). Recomendações Técnicas para o Uso Agrícolavdo Composto de Lixo Urbano no Estado de São Paulo. Circular Técnica. Ministério da Agricultura. Pecuária e Abastecimento. Campinas.

Stellacci AM, Cristiano G, Rubino P, De Lucia B, Cazzato E (2013). "Nitrogen uptake, nitrogen partitioning and N-use efficiency of container-grown holm oak (*Quercus ilex* L.) under different nitrogen levels and fertilizer sources". Int. J. Food Agric. Environ. 11:3-4, 132–137.

Torri SI, Corrêa RS, Renella G, Vadecantos A, Perelomov L (2012). Biosolids soil application: why a new special on an old issue?. Appl. Environ. Soil Sci. 3 pp.

Wendling I, Gatto A (2002). Substratos, adubação e irrigação na produção de mudas. Viçosa: Aprenda Fácil Editora. P. 166.