

FIELD PERFORMANCE OF *SWIETENIA MACROPHYLLA* KING. SAPLING IN MUNICIPAL GARBAGE AS THE POTTING MEDIA FOR REFORESTATION IN THE TROPICS

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Abstract : The term 'garbage' used internationally to describe waste materials arising from domestic, trade, commercial, industrial, agricultural and other related activities and from public services. It has created a real threat not only to the living environment but also for the cultivation of crops as well as afforestation. The present investigation was conducted to study the influence of two weeks decayed or stored waste materials as component potting media on the growth and vigour of *Swietenia macrophylla* (Mahogany) seedlings. The survival rate was ranged from 96 per cent to 99 per cent among various treatments studied. Mixture of soil, partially decayed tea waste and sand was recorded the maximum height in nursery and T1 (Control - Soil: Sand: cow dung) recorded maximum collar diameter (9.35 mm). With regards to height (155.62 cm) and diameter (14.2 mm), the maximum performance was registered in potting media containing soil and partially decayed Municipal waste (T2) in sapling level. Height and diameter increment at nursery level after eighth month showed the maximum increase was in T7 (28.32 per cent) and -3.53 per cent as compared to the control (T1) in seedling level and maximum increment per cent in the plantation was recorded in T2 (45.28) and T4 (49.55) for height and diameter respectively. The combined use of soil with garbage result in the production high quality planting material and the effect of plantation development were very less.

Keywords: *Swietenia macrophylla*, potting media, survival rate, diameter, height, increment percentage

INTRODUCTION

Swietenia macrophylla (Meliaceae) is the promising species in the round wood. It is able to tolerate a very wide range of environmental conditions and is found naturally in both tropical dry and wet forest types. The economic importance of timber may due to the attractive light reddish colour and high durability. During the past few years the demand for mahogany was tremendously increased. It has special attention due to the wood quality, workability and less insect attack. In the recent times Mahogany gained a wide acceptance among the tree growers in Kerala. In Kerala, despite the favorable agroclimatic and edaphic conditions and the concomitant production potential, the forest plantations contribute marginally to meet the state wood demand (less than 25%) reported by Krishnankutty, (1990). Establishing forest plantations to meet the ever-increasing demand for tree products have been a long standing tradition in the tropics (Evans, 1990). Apart from alleviating the pressure on the primary forest, plantations offer continuous production of wood materials through intensive management practices. Besides the direct economic benefits the ecological dimensions, plantation forestry have attained greater importance in the recent times in view of the invaluable contribution they provide in regulating atmospheric CO₂ emission and there by playing a dominant role in mitigating climatic change (IPCC, 2007). The natural regeneration and establishment were only scarce. So the production of quality material was a challenging topic and that is the reason for the selection of this species.

Municipal solid waste is a heterogeneous mass of

discarded waste material of industrial and commercial activities of human being. They are normally non-flowing materials such as plastic, paper metal, glass, kitchen wastes and market wastes (Sharma, 2002). Spooner (1971) has reported that solid waste comprise countless different materials like dust, food waste, packaging in the form of paper, metals, plastic, glass pieces, discarded clothing and furnishings, garden waste and hazardous and radioactive wastes. With the looming urbanization and changes in lifestyle and food habits, municipal solid waste has been proliferating rapidly and its composition keeps changing periodically (Umpathy, 2003). Solid waste management is the effort of removing and disposing all the unwanted material through a carefully, planned and judicious use of means. Shah, (2000) reiterated the planning, financing, construction and operation of facilities for the collection, transportation, recycling and final disposition of solid waste. It is based on principles such as engineering, economics, public health, conservation, aesthetics, environmental considerations and social and ethical issues.

The research studies conducted elsewhere revealed that the waste materials like municipal garbage could be used for cultivation of vegetables and ornamentals particularly when supplemented with some nutrients. But information regarding the effect of these solid wastes on the growth and vigour of tree seedlings either in the nursery or in the plantation are very scanty. Scientific information on the influence of municipal garbage on growth behavior of seedlings will be extremely useful for the production of healthy seedlings in the nursery at low cost, same time

paving a way for the easy disposal of these waste materials.

Hence, the present investigations were carried out in the College of Forestry, Kerala Agricultural University, Vellanikkara. The overall objective of this study was to determine the effects of two weeks decayed or stored waste materials as component potting media on the survival, growth and vigour of Mahogany seedlings in the nursery and media influence on field. We addressed three specific questions: (1) Did municipal garbage as potting media affect survival and growth of *Swietenia macrophylla* seedlings? (2) Did municipal garbage as potting media affect growth in plantation level of *Swietenia macrophylla*?

MATERIAL AND METHOD

In the present investigation, it is proposed to study the effect of two weeks decayed or stored waste materials as component potting media on the survival rate and field performance of Mahogany seedlings. The experiment was conducted at College of Forestry, Kerala Agricultural University and Vellanikara during the period 2009-2012. The nursery area is located at 40 meters above mean sea level at 10°32'N latitude and 76°26'E longitude. The area experiences a warm and humid climate with distinct rainy season. Mature mahogany seeds were collected from Mananthavady, Wayanad district. The seeds/pods were brought to the college nursery and dried under partial shade. Seeds/pods were extracted for the study. Seeds were sown in standard nursery beds. Uniform vigorous seedlings were transplanted in polythene bags of 10"x5" size filled with different treatment media and arranged in separate rows in the green house. Watering was done regularly.

The following 7 potting media were prepared by thoroughly mixing the components.

T1 - Soil: Sand: cow dung (1:1:1 ratio- control treatment)

T2- Soil: partially decayed Municipal waste (1:1)

T3 - Soil: partially decayed Coir waste (1:1)

T4- Soil: partially decayed Tea waste (1:1)

T5 - Soil: partially decayed Municipal waste: Sand (1:1:1)

T6 - Soil: partially decayed Coir waste: Sand (1:1:1)

T7 - Soil: partially decayed Tea waste: Sand (1:1:1)

The experiment was laid out in Complete Randomized Block Design (CBD) with three replications. A total of one thousand and fifty seedlings were kept for conducting growth studies. The seedlings after transplanting to the polybags were kept under green house conditions. Necessary plant protection measures were also adopted.

Initial establishment after one week of planting and final survival rate were recorded. The seedlings were kept in 50% shade house about eight months for its proper care and protection from seedling mortality. The height and collar diameter at monthly intervals were collected using scale and digital vernier caliper respectively. An experimental plot was established to study the growth performance of Mahogany seedlings in the field. Field observations were undertaken 70 seedlings planted in Randomized block design at a spacing of 2 x 2 m. Growth in height and diameter of seedlings was taken in the field at monthly intervals up to one year after planting in the field.

Statistical Analysis

Complete Randomized Block experimental design was used for all analyses performed in the experiment. All treatments were replicated four times. Data were analyzed using SPSS (version 20.0, SPSS Institute, Chicago, IL, USA). The shoot height and collar diameter were statistically analyzed using one-way ANOVA with LSD test for multiple comparisons ($\alpha=0.05$).

RESULT

The observations on the initial survival rate after one week of planting and final survival rate after eight months of planting of the seedlings of mahogany are given below in Fig 1. The survival rate was ranged from 96 per cent to 99 per cent among various treatments studied. Treatment T4 [Soil: partially decayed tea waste (1:1)] and T7 [Soil: partially decayed Tea waste: Sand (1:1:1)] showed 2 to 4 per cent mortality. However, T3 [Soil: partially decayed Coir waste (1:1)] and T6 [Soil: partially decayed Coir waste: Sand (1:1:1)] showed relatively low rate of mortality. Leaf fall and yellowing were more prominent in T4 and T7.

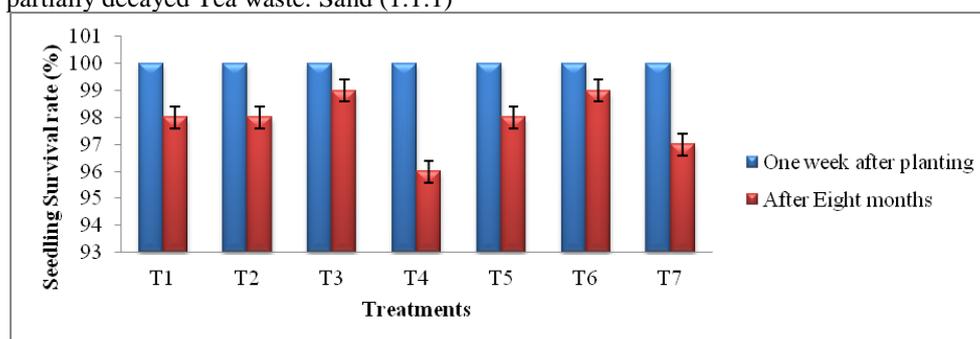


Fig 1. Survival rates of seedlings in different intervals under various treatments of *Swietenia macrophylla* seedlings

Significant variation was observed among various treatments with regard to height of seedlings. However, it was not conspicuous at different intervals up to the end of the study. Treatment T7 [Soil: partially decayed Tea waste: Sand (1:1:1)] recorded the maximum height of 56.10 cm, which was immediately followed by T5 [Soil: partially

decayed Municipal waste: Sand (1:1:1)], and T2 [Soil: partially decayed Municipal waste (1:1)]. Whereas treatment T3 [Soil: partially decayed Coir waste (1:1)] showed the lowest value (36.73 cm). It indicated that the influence of potting media on height growth.

Table 1. Height (cm) under different treatments of *Swietenia macrophylla* at monthly intervals in nursery

Months	Treatments						
	T1	T2	T3	T4	T5	T6	T7
Jul	18.42 ^b	16.69 ^d	12.50 ^f	17.44 ^c	16.65 ^d	15.21 ^e	21.90 ^a
Aug	24.75 ^d	25.41 ^c	18.54 ^g	21.82 ^e	26.23 ^b	19.59 ^f	27.13 ^a
Sept	29.46 ^d	32.55 ^c	20.80 ^f	29.52 ^d	34.71 ^b	22.46 ^e	35.86 ^a
Oct	30.92 ^e	37.26 ^c	22.30 ^g	32.79 ^d	38.89 ^b	25.45 ^f	44.57 ^a
Nov	32.80 ^e	38.94 ^c	23.27 ^g	34.07 ^d	42.79 ^b	26.74 ^f	46.02 ^a
Dec	36.98 ^d	41.61 ^c	24.29 ^f	36.61 ^d	46.77 ^b	29.59 ^e	48.00 ^a
Jan	40.24 ^d	46.35 ^c	27.86 ^f	39.60 ^d	49.58 ^b	34.45 ^e	52.74 ^a
Feb	43.72 ^d	48.78 ^c	31.05 ^g	41.87 ^e	52.02 ^b	36.73 ^f	56.10 ^a

** Significant at 0.01 levels

Means with same letter as superscript are homogeneous

Significant variation was also observed among various treatments with regard to collar diameter of seedlings at various months (Table 2). Treatment T1 [Soil: Sand: cow dung (1:1:1)] recorded maximum collar diameter (9.35 mm) at the end of the study. Treatment T4 [Soil: partially decayed Tea waste (1:1)] was on par with treatment T5 [Soil: partially

decayed Municipal waste: Sand (1:1:1)]. Treatment T3 [Soil: partially decayed Coir waste (1:1)] recorded lowest value (5.97 mm) in collar diameter. With regards to the advancing intervals, significant variation was observed among treatments at the end of the study period when compared to the initial phase.

Table 2. Mean diameter (mm) under different treatments of *Swietenia macrophylla* at monthly intervals in nursery

Months	Treatments						
	T1	T2	T3	T4	T5	T6	T7
Jul	2.38 ^d	2.61 ^b	2.01 ^e	2.41 ^d	2.47 ^c	2.40 ^d	2.68 ^a
Aug	3.68 ^b	3.73 ^b	2.70 ^e	3.88 ^a	2.93 ^d	2.80 ^{de}	3.48 ^c
Sept	5.01 ^b	5.86 ^a	3.85 ^f	4.14 ^e	5.89 ^a	3.39 ^d	4.64 ^c
Oct	6.00 ^b	6.13 ^a	4.27 ^d	5.59 ^c	6.13 ^a	4.16 ^e	6.10 ^{ab}
Nov	6.27 ^b	6.63 ^a	4.74 ^c	6.12 ^b	6.72 ^a	4.65 ^c	6.65 ^a
Dec	6.69 ^c	7.40 ^a	5.34 ^e	7.07 ^b	7.50 ^{ab}	5.65 ^d	7.28 ^a
Jan	8.36 ^b	7.88 ^c	5.85 ^e	8.15 ^{bc}	8.13 ^{bc}	6.39 ^d	8.69 ^a
Feb	9.35 ^a	8.20 ^b	5.97 ^d	8.33 ^b	8.46 ^b	6.77 ^c	9.02 ^a

** Significant at 0.01 levels

Means with same letter as superscript are homogeneous

Performance of sapling planted in field revealed significant difference in height due to the effect of various potting media. The availability of nutrients in growing substrate greatly affects the growth of seedlings. With regards to height, the maximum performance (155.62 cm) was registered in T2 [Soil: partially decayed Municipal waste (1:1)] at the end of study period (Table 3) and the least (59.75 cm) height occurred in T6 [Soil: partially decayed Coir

waste: Sand (1:1:1)]. With regards to the height of the seedlings in the field, it increased from 75.59 (T3) to 155.61 (T2) at the end of the study. In the case of height, the treatment with maximum height in the beginning did not show the maximum height at the end of the study. In general increase in height at different intervals was not significant up to the end of the study i.e. 12 months.

Table 3. Height (cm) under different treatments of *Swietenia macrophylla* at monthly intervals in plantation

Months	Treatments						
	T1	T2	T3	T4	T5	T6	T7
April	60.38 ^{bc}	60.17 ^{bc}	47.39 ^a	64.17 ^c	62.17 ^{bc}	51.67 ^{ab}	70.63 ^c

May	66.83 ^b	64.67 ^b	48.99 ^a	69.42 ^b	64.33 ^b	52.00 ^a	69.42 ^b
June	68.86 ^b	76.32 ^b	50.37 ^a	73.12 ^b	65.92 ^b	52.50 ^a	72.92 ^b
Jul	74.03 ^{bc}	84.24 ^c	52.63 ^a	78.43 ^{bc}	67.50 ^b	53.17 ^a	73.72 ^{bc}
Aug	77.77 ^{bc}	92.49 ^c	53.67 ^a	84.82 ^{bc}	69.50 ^b	53.83 ^a	74.55 ^b
Sept	81.90 ^{bc}	104.92 ^d	54.92 ^a	94.90 ^{cd}	70.50 ^{bc}	54.33 ^a	75.25 ^b
Oct	85.98 ^{bc}	110.80 ^d	55.83 ^a	99.42 ^{cd}	71.58 ^{ab}	54.83 ^a	76.26 ^{ab}
Nov	90.98 ^{bc}	112.90 ^c	57.33 ^a	104.08 ^c	72.98 ^{ab}	55.50 ^a	72.98 ^{ab}
Dec	95.48 ^{bc}	116.27 ^c	65.42 ^a	109.53 ^c	74.00 ^{ab}	56.17 ^a	79.25 ^{ab}
Jan	99.62 ^{bc}	126.91 ^d	67.48 ^a	114.39 ^{cd}	75.58 ^{ab}	57.50 ^a	80.25 ^{ab}
Feb	103.92 ^{bc}	142.44 ^d	71.07 ^a	128.55 ^{cd}	76.50 ^{ab}	58.50 ^a	84.00 ^{ab}
March	107.12 ^c	155.62 ^d	75.59 ^{ab}	140.51 ^d	78.58 ^{ab}	59.75 ^a	89.15 ^{bc}

** Significant at 0.01 levels

Means with same letter as superscript are homogeneous

The collar diameter was reported in the range of 5.5 mm to 30.1 mm. A greater collar diameter (14.2) was recorded for T2 [Soil: partially decayed Municipal waste (1:1)] and lowest values of collar diameter (5.5) was reported for T6 [Soil: partially decayed Coir waste: Sand (1:1:1)] at the beginning of the field performance (Table 4). The treatment with maximum

collar diameter (30.1) T4 [Soil: partially decayed Tea waste (1:1)] and least (13.3) value recorded for T6 [Soil: partially decayed Coir waste: Sand (1:1:1)] at the end of study period. There was no significant increase in collar diameter at different intervals from the beginning to the end of the study.

Table 4. Mean diameter (mm) under different treatments of *Swietenia macrophylla* at monthly intervals in plantation

Months	Treatments						
	T1	T2	T3	T4	T5	T6	T7
April	12.4 ^c	14.2 ^c	9.0 ^b	12.4 ^c	7.8 ^{ab}	5.5 ^a	7.5 ^{ab}
May	13.3 ^c	15.0 ^c	9.5 ^b	14.0 ^c	8.4 ^{ab}	5.9 ^a	8.6 ^{ab}
June	13.9 ^c	16.0 ^c	10.2 ^b	15.8 ^c	9.4 ^b	6.1 ^a	9.5 ^b
Jul	14.7 ^c	17.1 ^c	10.9 ^b	17.8 ^c	10.4 ^b	6.8 ^a	10.6 ^b
Aug	15.2 ^c	18.4 ^{cd}	11.3 ^b	18.9 ^d	11.2 ^b	7.3 ^a	11.3 ^b
Sept	15.8 ^c	19.2 ^{cd}	11.7 ^b	19.7 ^d	11.9 ^b	8.2 ^a	12.2 ^b
Oct	16.7 ^{cd}	20.2 ^{de}	12.4 ^{ab}	21.5 ^e	13.9 ^{bc}	9.1 ^a	12.9 ^{abc}
Nov	17.2 ^c	21.9 ^d	13.0 ^{ab}	23.1 ^d	14.5 ^{bc}	10.0 ^a	13.8 ^{abc}
Dec	17.5 ^b	23.2 ^c	13.3 ^{ab}	25.3 ^c	15.0 ^{ab}	10.7 ^a	14.2 ^{ab}
Jan	18.2 ^b	24.1 ^c	13.7 ^a	27.1 ^c	15.3 ^{ab}	11.6 ^a	14.7 ^{ab}
Feb	19.1 ^b	25.4 ^c	14.0 ^a	29.2 ^c	15.7 ^{ab}	12.4 ^a	15.4 ^{ab}
March	20.1 ^b	26.4 ^c	14.4 ^a	30.1 ^c	16.3 ^{ab}	13.3 ^a	16.0 ^{ab}

** Significant at 0.01 levels

Means with same letter as superscript are homogeneous

The increment percent calculated for the growth in height and diameter in nursery level at the end of the study. The availability of nutrients in growing substrate greatly affects the growth of seedlings. With regards to height and diameter increment at

nursery level after eighth month showed the maximum increase was in T7 (28.32 per cent) and -3.53 per cent as compared to the control (T1) (Fig 2). The least (-28.98 and -36.15 %) height and collar diameter respectively was registered in T3.

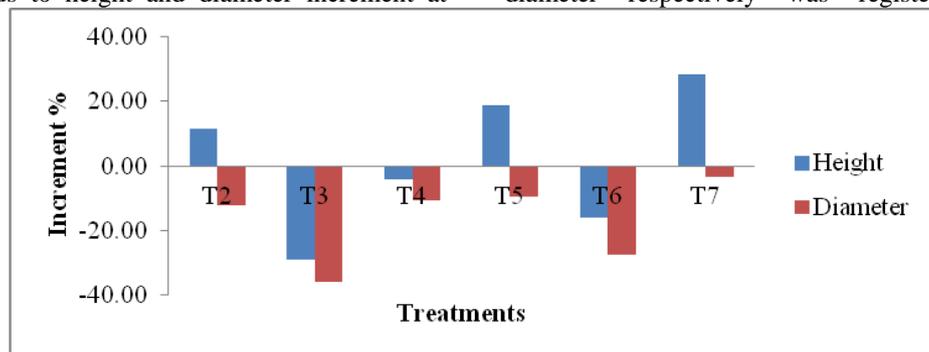


Fig 2. Increment percentage in height and collar diameter under different treatments of *Swietenia macrophylla* in the nursery

The increment percent was also calculated for the growth in height and diameter in plantation level at the end of the study. It indicated that maximum increment per cent in the plantation was recorded in

T2 (45.28) and T4 (49.55) for height and diameter respectively. The least increment was observed in T6 (-44.22 and -33.83) respectively for height and diameter as compared with control (T1) (Fig 3).

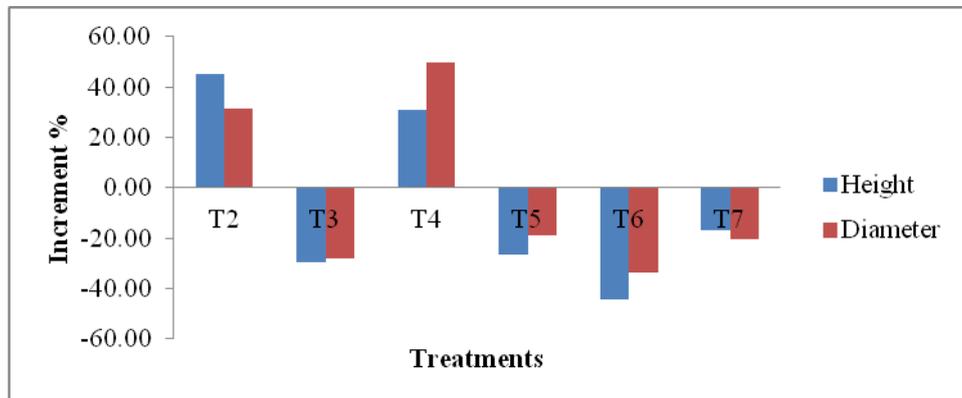


Fig 3. Increment percentage in height and collar diameter under different treatments of *Swietenia macrophylla* in plantations

DISCUSSION

Disposal of solid waste has a major problem in the country, especially in Kerala as the availability of land fill sites have diminished and requirements for making landfills environmentally acceptable have driven up the costs substantially. Reuse of organic wastes in agriculture holds promise in general, since they offer a locally available fertility resource, and their removal provides an effective and environmentally acceptable option of waste disposal. The present study investigates the effect of municipal garbage and industrial waste as a component of potting media on the growth and vigour of mahogany in nursery as well as in the field.

Partially decomposed municipal garbage and Industrial waste when used as a component potting media were not significantly influenced the survival rate of seedlings. Survival of seedlings was ranged from 95 to 100 per cent. Survival was found maximum in both treatments T2 [Soil: partially decayed Municipal waste (1:1)] and T3 [Soil: partially decayed Coir waste (1:1)]. It could be stated that survival rate was directly proportional to the period of decomposition of garbage. Gopikumar *et al.* (2002) have conducted a study to find out the effect of garbage and coir dust on establishment and growth of seedlings of *Tectona grandis*, *Ailanthus triphysa* and *Albizia falcataria*. The study revealed seedlings when planted in potting media of soil: sand: cowdung and soil: coir: dust recorded 100 per cent success with regard to both initial establishment and final survival rate. Gopikumar, (2009) reported the potting media containing municipal garbage, initial establishment were found to be good in *Dalbergia latifolia*.

A balanced rooting medium that contains an adequate supply of nutrients is essential for plants to attain maximum growth and development. Balanced

rooting media greatly affects the plant height and availability of growing substrate with the supplement of essential nutrients is essential for attaining maximum plant height (Ikram *et al.* 2012). It was observed from this experiment that, compared to other media, municipal garbage should be considered high ranking as a potting medium for plant height. Results showed that coconut coir waste, tea waste alone and in combination with soil contributed to produce maximum plant height. Plant height is also greatly affected by the environment, especially root medium. Results indicated that using different substrates in differing proportion as potting mix had different effects on plant height. With regards to height, maximum value was recorded by treatment T7 [Soil: partially decayed Tea waste: sand (1:1:1)] in mahogany. This is in agreement with the findings of other research trials as represented by Adersh (2001) in teak. Similar results were also observed from the studies of Herrera *et al.* (2008), Mehmood *et al.* (2013), Ribeiro *et al.* (2000), Sharifian *et al.* (2014), Tariq *et al.* (2012) and Wilson *et al.* (2002). Reported that addition of cowdung can improve soil physical properties and also nutrient availability and this may be the probable reason for the better growth of seedlings in potting media containing cowdung (Adersh, 2001). Treatment with sand and coir pith (T3) represented lowest height. Vidyasagran *et al.*, 2014 reported the use of mixture of soil, sand and municipal garbage can optimize the quality of mahogany seedlings in nursery.

Plants exhibiting maximum stem diameter with strong vigor can be used successfully. Collar diameter of the seedlings at end of the study revealed a different response to various potting media applied. Here maximum values were registered in both treatment T1 [Soil: Sand: cow dung (1:1:1 ratio-control treatment)] and T2 [Soil: partially decayed Municipal waste (1:1)]. However minimum collar

diameter was recorded in treatment T3 for mahogany. Addition of coir waste to soil proved less influence on collar diameter and height. Sharifian *et al.* (2014) have noticed greater shoot weight of sugar maple seedlings when grown in green house medium. The nutrient content in the potting media have a high effect in the growth increment in seedlings. The partly decomposed garbage has high nutrient content and air space for the conduction of air and water. It may be the reason for the increment in the growth. Similar observations were reported by many research trials. Mohan *et al.* (1991) have reported that a combination of soil, sand and FYM in the ratio 1:1:1 increased the height and dry matter production of seedlings of *Swietenia macrophylla* and *Dalbergia latifolia*. Gopikumar, (2009) reported *Dalbergia latifolia* showed a positive response on growth and vigour in terms of shoot growth parameters were found to be most promising when the seedlings were grown in potting media containing 4 weeks decomposed municipal garbage and soil: sand: cowdung.

The use of garbage waste for the preparation of potting media provides plants with significant quantities of essential nutrients, which should be taken into account in fertirrigation. This is an important result, in economic term, the production of quality seedlings were ensured, the cost of production may be decreased and the reduction in environmental pollution. The study revealed that the use of garbage with soil can provide high seedling survival rate for *Swietenia macrophylla*, good drainage, water holding capacity, aeration and optimum nutrient, ultimately lead to the production of good stoke and mitigate environmental pollution. The experimental trial in plantation showed, there was no significant effect for the potting media.

CONCLUSION

Urban waste materials are not always adequately used in current commercial, afforestation practices, such as nurseries, despite the possible immediate benefits from using them, especially if they are readily available and less expensive than traditional substrates like peat, vermiculite etc. This work shows that the utilization of municipal garbage as potting media at nurseries has proven to be a useful procedure to obtain suitable growing media for the propagation of commercially important tree species *Swietenia macrophylla* (Mahogany) seedlings, which are frequently used for afforestation in tropics. In general, plant growth and nutrition were enhanced by using the municipal solid waste-based compost for this purpose. The use at nursery of this kind of domestic refuse could contribute to solve two important problems: waste disposal (which is becoming a serious problem in many countries) and limit in ecological problems (mining for sand and peat).

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REFERENCES

- Adersh, M.** (2001). Municipal garbage as a component of potting media for seedlings of selected forest tree species. M.Sc. Thesis, Kerala Agricultural University, Thrissur.
- Evans, J.** (1990). Planted forests of the wet and dry tropics, their variety, nature and significance. *New for.*, 17: 25-36.
- Gopikumar, K.** (2009). Effect of garbage on performance of rosewood (*Dalbergia latifolia*) seedlings in the nursery. *International Journal of Plant Sciences*, 4 (2) : 346-351.
- Gopikumar, K., Minichandran and Vidyasagan, K.** (2002). Growth performance of selected tropical forest tree species as influenced by potting media containing garbage. *Advances in Forestry Research in India.* (ed. Prakash, R.). International Book Distributors. Dehra Dun, 149p.
- Herrera, F.; Castillo, J.E.; Chica, A.F. and Bellido, L.L.** (2008). Use of municipal solid waste compost (MSWC) as a growing medium in the nursery production of tomato plants, *Bioresource Technology*, 99: 287 – 296.
- Ikram, S., Habib; U. and Khalid, N.** (2012). Effect of different potting media combinations on growth and vase life of Tuberose (*Polianthes Tuberosa* Linn.). *Pakistan Journal of Agricultural Sciences*, 49(2): 121-125.
- IPCC,** (2007): Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K. B. Averyt, M. Tignor and H. L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. 996p.
- Krishnankutty, C.N.** (1990). Demand and supply of wood in Kerala and their future trends. Research Report 67. Kerala Forest Research Institute, Peechi, Kerala, 66p.
- Mehmood, T.; Ahmad, W.; Ahmad, K.S.; Shafi, Y.; Shehzad, M.A. and Sarwar M.A.** (2013). Comparative Effect of Different Potting Media on Vegetative and Reproductive Growth of Floral Shower (*Antirrhinum majus* L.). *Universal Journal of Plant Science*, 1(3): 104 – 111.
- Mohan, S.; Prasa, K.G. and Gupta, G.N.** (1991). Fertilizer response of selected social forestry species under varying soil texture. *The Indian Forester*, 111: 49 – 57.
- Ribeiro, H.M.; Vasconcelos, E. and dos Santos, J.Q.** (2000). Fertilisation of potted geranium with a

municipal solid waste compost. *Bioresource Technology*, 73: 247 – 249.

Shah, K.L. (2000). Basics of solid and hazardous waste management technology, Prentice hall, USA.

Sharifian, Z.; Mood, A.A.M. and Mohamadi, N. (2014). Effect of different ratios of municipal solid waste compost on growth parameters and yield of Marigold (*Calendula officinalis* Moench.) and Daisy (*Bellis Perennis* L.). *International journal of Advanced Biological and Biomedical Research*, 2(1): 43 – 50.

Sharma, P.C. (2002). Energy from municipal waste: An overview with special reference to India. *Tree India Environ. J.* 16: 1-9.

Spooner, C.S. (1971). Solid Waste Management in Recreational Forest Areas. EPNOSWWP Publication. S. Wales, pp 81-95.

Tariq, U.; Rehman, S.U.; Khan, M.A.; Younis, A.; Yaseen, M. and Ahsan, M. (2012). Agricultural and municipal waste as potting media components for the growth and flowering of *Dahlia hortensis* 'Figaro'. *Turkish Journal of Botany*, 36: 378 - 385.

Umapathy, A. (2003). Rational practices for environmental conservation. *Environ. Sci. Engng*, I: 11-17.

Vidyasagran, K.; Ajeesh R. and Vikas Kumar. (2014). Use of municipal garbage for the production of quality *Swietenia macrophylla* King. Seedlings. *Nature Environment and Pollution Technology* . Vol. 13, No.4 (In Press).

Wilson, S.B.; Stoffella, P.J. and Graetz, D.A. (2002). Development of compost based media for containerized perennials. *Scientia horticulturae*, 93: 311 – 320.

