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Research article

FIELD PERFORMANCE OF *AILANTHUS TRIPHYSA* 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 *Ailanthus triphysa* seedlings. The survival rate was ranged from 95 to 100 per cent among various treatments studied. Mixture of soil, partially decayed tea waste and sand was recorded the maximum height in nursery and T2 [Soil: partially decayed Municipal waste (1:1)] recorded maximum girth. With regards to height, the maximum performance (84.00 cm) was registered in mixture of soil, sand and cowdung and maximum collar diameter was reported in soil, partly decayed tea waste and sand (T7) in sapling level. Height increment at nursery level after eighth month showed the maximum increase was in T7 (21.27 per cent) and diameter increment 7.91 per cent in T2 as compared to the control (T1). Maximum increment per cent in the plantation was recorded in T7 (-3.08) and T5 (11.43) for height and diameter respectively at sapling level. The combined use of soil with garbage result in the production high quality planting material and the effect of plantation development were very less.
Key words: *Ailanthus triphysa*, potting media, survival rate, diameter, height, increment percentage

INTRODUCTION

Ailanthus triphysa commonly known as matti, (Family: Simaroubaceae) is a deciduous prominent multipurpose tree species in the traditional land use systems of Kerala, India. It occurs in natural evergreen forests of Western Ghats too [11]. The very light and soft wood is utilized for making packing cases, catamarans, toys, and drums. Most important use is in match industry due to straight grain and without any deposition in wood. The tree also yields a high viscous aromatic resin that is widely used as incense and in indigenous medicines. In Kerala, ailanthus occurs in all physiographic provenances except in the high hills and it tolerate a wide range of soils [8]. 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, [7]. Establishing forest plantations to meet the ever-increasing demand for tree products have been a long standing tradition in the tropics [2]. 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 CO_2 emission and there by playing a dominant role in mitigating climatic change [7]. 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 [15]. Spooner [16] 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 [18]. Solid waste management is the effort of removing and disposing all the unwanted material through a carefully, planned and judicious use of means.

Shah, [13] 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 *Ailanthus triphysa* 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 *Ailanthus triphysa* seedlings? (2) Did municipal garbage as potting media affect growth in plantation level of *Ailanthus triphysa*?

MATERIAL AND METHODS

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 $10^0$32'N latitude and $76^0$26'E longitude. The area experiences a warm and humid climate with distinct rainy season. The seeds were collected from KFRI (Kerala Forest Research Institute) Seed Centre. 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 *Ailanthus* seedlings in the field. Field observations were undertaken 70 seedlings planted in Randomized block design at a spacement 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 (a=0.05).

RESULTS

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 *Ailanthus triphysa* are furnished in Fig. 1. The survival rate of seedlings after 8 months of observation indicated that variation in survival rate among treatments. The treatment T2 [Soil: partially decayed Municipal waste (1:1)], T3 [Soil: partially decayed Coir waste (1:1)], T5 [Soil: partially decayed Municipal waste: Sand (1:1:1)] and T6 [Soil: partially decayed Coir waste: Sand (1:1:1)] showed 100 per cent survival. Mortality was relatively more in T1 followed by T7 and T4. It was ranged from 95 to 100 per cent among various treatments studied.

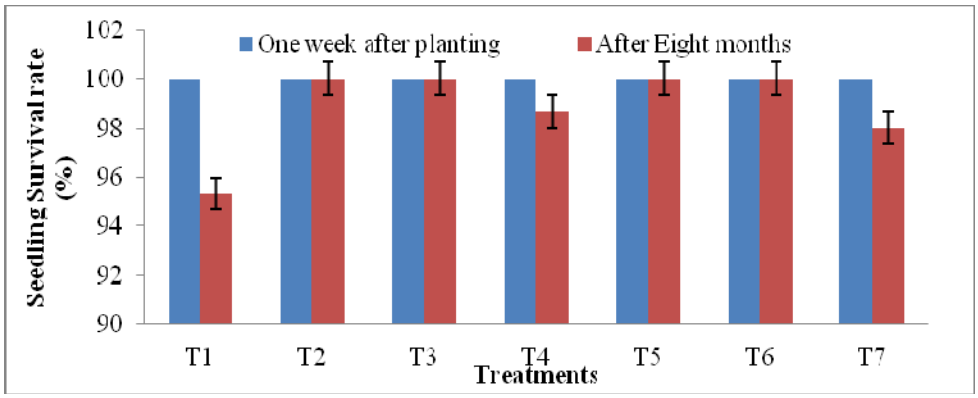

Fig 1. Survival rates of seedlings in different intervals under various treatments of *Ailanthus triphysa* seedlings

Significant variation was observed among various treatments with regard to height of seedlings (Table. 1). Treatment T7 [Soil: partially decayed Tea waste: Sand (1:1:1)] recorded the maximum height of 56.10 cm, which was immediately followed by T2 [Soil: partially decayed Municipal waste (1:1)] and T5 [Soil: partially decayed Municipal waste: Sand (1:1:1)]. Whereas treatment T3 [Soil: partially decayed Coir waste (1:1)] recorded the lowest value with regard to height. It indicated that the influence of potting media on height growth. In the initial months, T7 [Soil: partially decayed Tea waste: Sand (1:1:1)] and T1 [Soil: Sand: cow dung (1:1:1)] exhibited variation in height between intervals. However, at the end of the study there was significant variation between treatments.

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

Months	Treatments						
	T1	T2	T3	T4	T5	T6	T7
Jul	5.91^{c}	5.17^{b}	4.21^{a}	5.076^{b}	5.12^{b}	4.60^{ab}	4.99^{b}
Aug	7.99^{b}	10.85^{c}	4.85^{a}	10.43^{b}	12.48^{d}	6.00^{a}	12.91^{d}
Sept	14.25^{ab}	14.57^{ab}	6.88^{a}	16.49^{bc}	20.94^{c}	7.87^{a}	22.43^{d}
Oct	25.29^{b}	29.67^{c}	8.81^{a}	24.70^{b}	30.63^{c}	9.81^{a}	31.95^{c}
Nov	34.34^{bc}	37.94^{cd}	10.92^{a}	31.36^{b}	39.40^{d}	11.88^{a}	40.53^{d}
Dec	40.64^{c}	44.72^{cd}	12.49^{a}	34.12^{b}	44.24^{cd}	13.96^{a}	49.09^{d}
Jan	46.10^{c}	50.50^{cd}	15.97^{a}	38.02^{b}	49.22^{c}	16.54^{a}	55.68^{d}
Feb	51.38^{c}	55.94^{cd}	20.97^{a}	42.22^{b}	53.99^{c}	21.18^{a}	62.31^{d}

** Significant at 0.01 levels

Means with same letter as superscript are homogeneous

Significant variation was observed among various treatments with regard to girth of seedlings at various months (Table. 2). Treatment T2 [Soil: partially decayed Municipal waste (1:1)] recorded maximum girth followed by T5 [Soil: partially decayed Municipal waste: Sand (1:1:1) during the period of study. However, in the initial months, none of the treatments showed significant variation. Treatment T3 [Soil: partially decayed Coir waste (1:1)] recorded lowest value. The girth value was ranged from 6.72 mm (T6) to 14.87 mm (T2). Monthly variation of growth in girth with respect to various treatments is depicted in table. 2.

Table 2. Girth (mm) under different treatments of *Ailanthus triphysa* at monthly intervals in nursery

Months	Treatments						
	T1	T2	T3	T4	T5	T6	T7
Jul	1.58^{ab}	1.45^{ab}	1.49^{ab}	1.73^{b}	1.37^{a}	1.56^{ab}	1.42^{ab}
Aug	2.06^{b}	2.49^{c}	1.82^{ab}	2.72^{cd}	2.82^{d}	1.76^{a}	2.82^{cd}
Sept	3.54^{b}	5.49^{e}	2.75^{a}	4.39^{c}	4.99^{d}	2.45^{a}	4.95^{d}
Oct	6.24^{c}	8.75^{d}	3.79^{b}	6.15^{b}	6.83^{bc}	3.14^{a}	7.16^{c}
Nov	7.98^{cd}	10.21^{e}	4.82^{b}	7.76^{c}	8.73^{d}	3.74^{a}	8.69^{d}
Dec	9.76c	11.79^{e}	5.92^{b}	9.30^{c}	10.59^{c}	4.70^{a}	10.64^{d}
Jan	11.74^{cd}	13.41^{e}	6.92^{b}	10.85^{c}	12.46^{de}	5.80^{a}	13.29^{c}
Feb	13.78^{d}	14.87^{c}	7.88^{b}	12.66^{c}	14.40^{de}	6.72^{a}	13.98^{d}

** 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 (84.00 cm) was registered in T1 [Soil: Sand: cow dung (1:1:1)] at the end of study period (Table 3) and the least (33.31 cm) height occurred in T6 [Soil: partially decayed Coir waste: Sand (1:1:1)]. 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. 9 months.

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

Months	Treatments						
	T1	T2	T3	T4	T5	T6	T7
April	67.80^{a}	68.40^{a}	29.20^{c}	52.30^{b}	69.60^{a}	27.06^{c}	74.20^{a}
May	71.30^{a}	69.76^{a}	29.86^{c}	53.38^{b}	69.67^{a}	27.83^{d}	75.07^{a}
June	72.80^{a}	70.67^{a}	30.81^{c}	54.21^{b}	70.89^{a}	28.65^{c}	75.82^{a}
Jul	74.30^{a}	71.60^{a}	31.31^{c}	55.10^{b}	72.32^{a}	29.15^{c}	76.80^{a}
Aug	76.30^{a}	73.00^{a}	32.19^{c}	56.40^{b}	73.13^{a}	29.90^{c}	77.78^{a}
Sept	78.30^{a}	74.09^{a}	33.11^{c}	56.48^{b}	74.03^{a}	30.67^{c}	78.97^{a}
Oct	80.50^{a}	75.18^{a}	34.08^{c}	57.49^{a}	74.83^{a}	31.50^{c}	79.76^{a}
Nov	82.70^{a}	76.32^{a}	35.05^{c}	58.26^{b}	75.43^{a}	32.30^{c}	80.61^{a}
Dec	84.00^{a}	77.45^{a}	36.30^{c}	59.59^{b}	76.63^{a}	33.31^{c}	81.41^{a}

** Significant at 0.01 levels

Means with same letter as superscript are homogeneous

The collar diameter was reported in the range of 9.12 mm to 16.27 mm. The treatment with maximum collar diameter were reported at the beginning (14.15) and end (16.27) of the study in T7 [Soil: partially decayed Tea waste: Sand (1:1:1)]. Lowest values of collar diameter (10.5) was reported for T3 [Soil: partially decayed Coir waste (1:1)] at the end of the field performance. 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 *Ailanthus triphysa* at monthly intervals in plantation

Months	Treatments						
	T1	T2	T3	T4	T5	T6	T7
April	13.01^{bc}	14.56^{a}	9.18^{d}	12.66^{c}	14.54^{a}	9.12^{d}	14.15^{ab}
May	13.26^{bc}	14.71^{a}	9.37^{d}	12.93^{c}	14.77^{a}	9.44^{d}	14.47^{ab}
June	13.36^{b}	14.90^{a}	9.52^{c}	13.23^{b}	14.98^{a}	9.54^{c}	14.77^{a}
Jul	13.50^{b}	15.09^{a}	9.65^{c}	13.43^{b}	15.37^{a}	9.96^{c}	15.08^{a}
Aug	13.66^{b}	15.26^{a}	9.88^{c}	13.61^{b}	15.59^{a}	10.23^{c}	15.29^{a}
Sept	13.88^{b}	15.40^{a}	10.07^{c}	13.79^{b}	15.77^{a}	10.47^{c}	15.46^{a}
Oct	14.12^{b}	15.67^{a}	10.20^{c}	13.93^{b}	15.94^{a}	10.70^{c}	15.66^{a}
Nov	14.19^{b}	15.82^{a}	10.34^{c}	14.07^{b}	16.02^{a}	10.95^{c}	15.95^{a}
Dec	14.60^{ab}	16.00^{a}	10.50^{c}	14.25^{b}	16.27^{a}	11.36^{c}	16.22^{a}

** 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 increment at nursery level after eighth month showed the maximum increase was in T7 (21.27 per cent) and diameter increment 7.91 per cent in T2 as compared to the control (T1) (Fig 2). The least (-59.18 and -51.23 %) height and collar diameter respectively was registered in T3 and T6.

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 T7 (-3.08) and T5 (11.43) for height and diameter respectively. The least increment was observed in T6 (-60.34) and T3 (-28.34) respectively for height and diameter as compared with control (T1) (Fig 3).

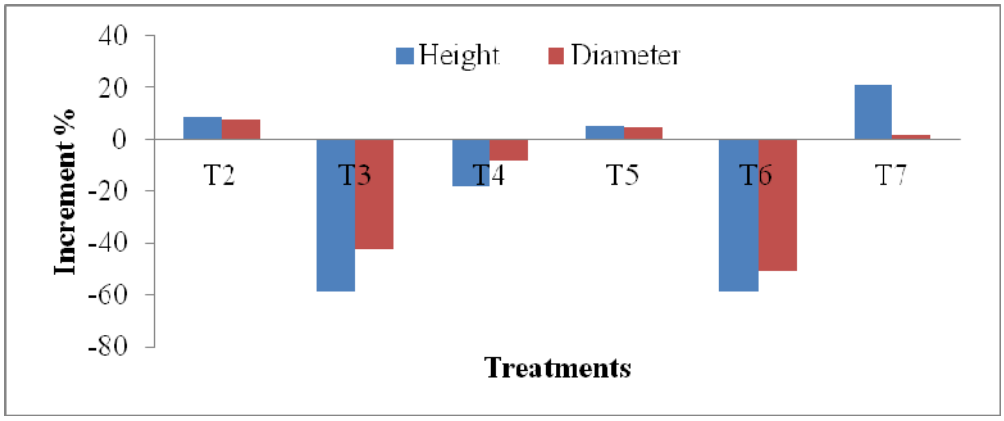

Fig 2. Increment percentage in height and collar diameter under different treatments of *Ailanthus triphysa* in the nursery

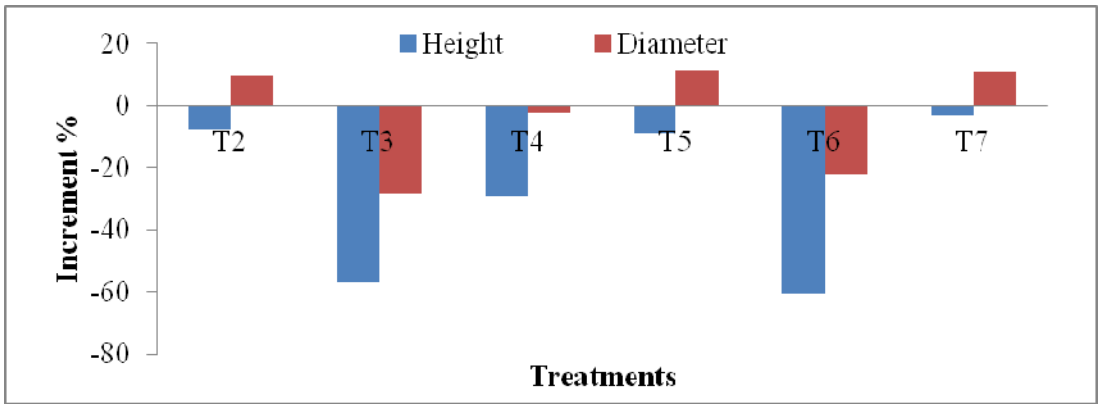

Fig 3. Increment percentage in height and collar diameter under different treatments of *Ailanthus triphysa* in plantations

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. The treatment T2, T3, T5 and T6 showed 100 per cent survival. Mortality was relatively more in T1 followed by T7 and T4. It could be stated that survival rate was directly proportional to the period of decomposition of garbage. Gopikumar et al. [4] 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. Gopikukar, [3] 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 [6]. 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.

Treatment T7 [Soil: partially decayed Tea waste: Sand (1:1:1)] recorded the maximum height. This is in agreement with the findings of other research trials as represented by Adersh [1] in teak. Similar results were also observed from the studies of Herrera et al. [5], Mehmood et al. [9], Ribeiro et al. [12], Sharifian et al. [14], Tariq et al. [17] and Wilson et al. [20]. Reported that addition of cowdung can improve soil physical propertied and also nutrient availability and this may be the probable reason for the better growth of seedlings in potting media containing cowdung [1]. Vidyasagran et al., [19] reported the use of mixture of soil, sand and municipal garbage can optimizes 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. Meanwhile, maximum girth was reported in T2 [Soil: partially decayed Municipal waste (1:1)]. Addition of coir waste to soil proved less influence on collar diameter and height. Sharifian et al. [14] 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 the reason for the increment in the growth. Similar observations were reported by many research trials. Mohan et al. [10] 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 *Swetenia macrophylla* and *Dalbergia latifolia*. Gopikumar, [3] 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 *Ailanthus triphysa*, 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 *Ailanthus triphysa* 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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