Journal of Ornamental Horticulture, 28 (1): 72-79, 2025 DOI NO.: 10.5958/2249-880X.2025.00014.5

Optimisation of rooting of plumeria species under different media and planting time

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ABSTRACT

Rise of urbanisation has led to increase in demands of ornamental trees to improve aesthetics as well as to tackle down the load of pollution generated by extensive anthropogenic activities. Plumeria trees, which possess both of these desirable traits, are favoured by growers. However, for mass production in nurseries, analysis of standardized growing time and rooting media is yet to be assessed to obtain the early and cheap planting material. Hence present study was carried out to determine the ability of various rooting media and planting time for early and better production *Plumeria rubra*. In present investigation three rooting media (*viz.*, Soil, Burnt Rice Husk (BRH) and Sand) that are commonly available to the nurseries were selected and *Plumeria rubra* were planted through hardwood cutting in two months (*viz.*, December and February). Burnt rice Husk was the best rooting media for the plants while the ideal conditions for rooting were of February with average relative humidity of 46.21 percent and mean temperature 18.82°C. *Plumeria rubra* was observed to have highest survival percentage (*i.e.*, 72 percent) along with better root and shoot growth in BRH. From the results, it can be concluded that February conditions resulted in better establishment of *Plumeria rubra* under open conditions while, burnt rice husk can serve as good media for the growth.

Key words: Burnt rice husk, media, plumeria, propagation, planting time, rooting,

INTRODUCTION

Plumeria is a popular tree species, widely used for landscaping due to unique and distinctive physical structure. Plumeria, which is commonly referred to as frangipani, is also appreciated for its attractive flowers. The flowers are characterized by their rounded petals arranged in a spiral pattern, and they come in various shades of white and red. Some of the species are deciduous in nature. Considering its dust accumulator behaviour along with pollution absorption capacity, the tree is highly promoted in urban areas (Chaturvedi *et al.*, 2013). Its high to moderate Air Pollution Tolerance (APTI) Index further scales up its uses in Industrial and polluted sites (Zenna *et al.*, 2019). In landscape gardening, the tree is utilised for avenues plantation, specimen tree and in container gardening. As a result, many amateurs and nursery man around the world are now involved in production of wide variety of Plumeria.

The tree is propagated by hardwood cuttings for mass production plants. The physical properties of rooting media, rooting conditions, cutting size

and type and parentage of plant are considered important components to enhance rooting (Tilt *et al.,* 1987). The current study focuses on the investigation of media, growing conditions and plant species for the better rooting and growth, that is feasible to the small nurseryman of the country. Good rooting media should possess certain characteristics such as appropriate porosity, sufficient nutrient availability, ability to hold water without becoming waterlogged, sterility to prevent pest and disease infestation, and high stability. During vegetative propagation of crops, sand and friable soil is the mostly used by small and marginal nurseryman for propagation. However, utilizing burnt rice husk, a by-product of paddy cultivation, can also be a cost-effective alternative. This medium is known for its porous nature, efficient water retention capabilities, and lightweight nature, making it a suitable choice for propagating plants. (Quintero *et al.,* 2013). Studies have suggested the use of BRH as either amendment in growing media with cocopeat or complete media itself in Celosia cristata, Oncidium baueri and Maxillaria picta (Faria *et al.,* 2001; Awang *et al.,* 2010; Evan 2011). Moreover, locally available material is likely to be cheaper over other imported medias. Sand is traditionally being used in nurseries for rooting in ornamental, however, low water holding capacity and low nutrition are the demerit one need to face while using it.

Growing time specifically the environmental conditions of the plant is another criterion that effect the root growth (Çelik and Cil, 2021). The cuttage suffers from water stress once detached from mother plant, that can be replenished only when the conditions provided supports minimum moisture loss and maximum water uptake (Mudge, 1995). This can be achieved by maintaining higher humidity levels and moderate temperatures. However, it is important to note that excessive humidity can lead to the development of biotic stress, which must also be taken into account. Higher survival rate in BRH can also be attributed to cutting's resistance towards pathogens that is directly correlated with the availability of silicon to the crop. Decrease in disease incidence due to higher silica was also reported in Momordica charantia L. (Ratnayake *et al.,* 2018)

Considering the high demand of tree in the market it is required to optimize the growing condition for early and high rooting of the Plumeria species. hence, the present study was undertaken to study the effect of planting time and propagating media on root growth and development for early and better establishment of plant.

MATERIALS AND METHODS

20 cm long hardwood cuttings of Plumeria species were taken from mature trees during two different months viz. of December and February. All the healthy cuttings were then quick dipped in IBA (1000 ppm) to improve rooting. Planting at the depth of 5 cm in three different media viz. Soil, Burnt Rice Husk (BRH) and Sand were done subsequently after drenching with water. After 8 weeks, cuttings were evaluated for the survival rate (percent), root length (cm), number of roots, number of branches, stem diameter (cm) and plant height (cm). The study was carried out during 2019-21 at Punjab Agricultural University, Ludhiana.

Three media namely Sand, Soil and Burnt Rice Husk were studied. Sand was clarified with acid and thoroughly washed with water for avoid any contamination. The pH was maintained at 7.2. Soil physical component consists of 61 percent sand, 23 percent silt and 16 percent clay. The available water content was 12 percent in soil,

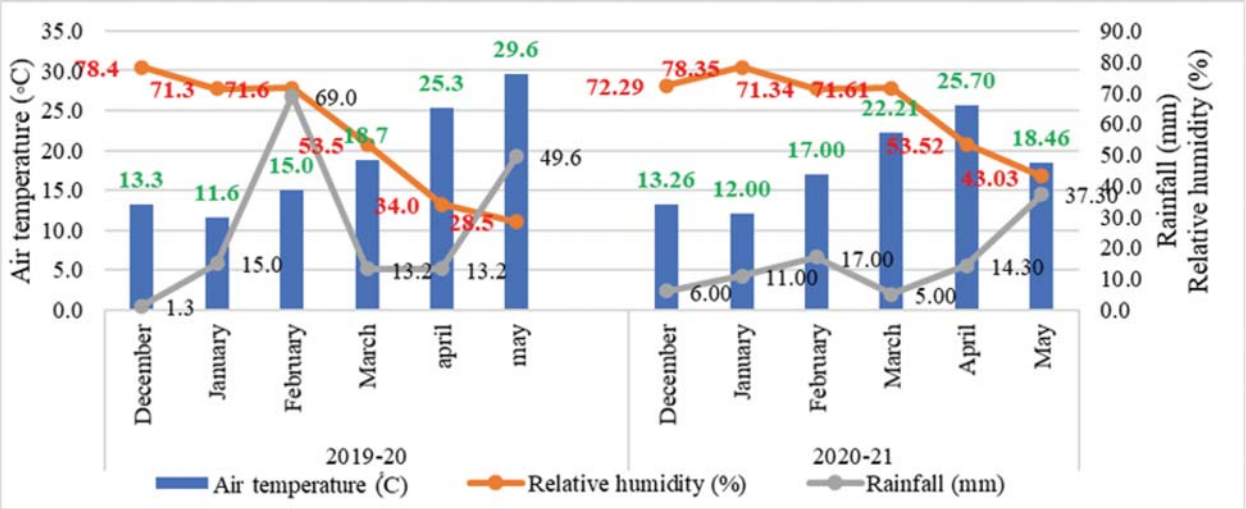


Fig. 1: The average temperature and average relative humidity of the growing location during growing months after cutting.

5 percent in sand and 3 percent in burnt rice husk.

The study was conducted in Factorial Randomized Block Design (FRBD). The treatment combination includes 3 × 2 (6) combinations propagating media and propagating month, respectively. In each replicate five plants were analysed to study growing characteristics and the experiment was carried out 2 times. IBM SPSS ver. 26 software was used to carry out the statistical analysis under three factor analysis of variance (ANOVA). Duncan's Multiple Range test (DMRT) was used for post-hoc analysis at $p<0.05$ significant difference.

RESULTS AND DISCUSSION

Vegetative attributes : Major variation in plant height was observed between cutting planted in December and February (Table 1). Plant height in February (24.20 ± 1.67 cm) were 43.51 per cent longer than December planted one (10.53 ± 3.39 cm). In between media, BRH had significantly longer length (19.40 ± 4.35 cm) than sand (17.30 ± 6.23 cm) and soil (15.40 ± 3.25 cm). Significantly higher height was observed in BRH planted in February (28.00 ± 3.39 cm) which was 30.71 percent higher than lowest height observed among the treatments i.e., in soil × December (8.60 ± 0.40 cm). Following BRH × February, higher height was observed in plants planted in soil × February (22.20 ± 0.66 cm) and sand × February (22.40 ± 1.25 cm).

Branch number also varied among plants planted in December and February, however, no significant difference was observed between media and interaction of media with planting time. February had higher number of branches (1.7 ± 0.28) than December planted cuttings (1.1 ± 0.12) (Table 1).

The *Plumeria rubra* is responsive to planting time (February) having temperature of 15°C and 17°C along with relative humidity of 71.60 per cent and 71.61 per cent in the year 2019-20 and 2020-21, respectively. Although, the average humidity of December is comparable with that of February, following 30 days temperature reaches to 13°C which might have reduces the hydrolysis of sugars and its mobilisation to the

Table 1: Effect of media and planting time on the vegetative and rooting attributes of *Plumeria rubra*.

	Plant height (cm)			Number of branches			Number of roots			Crown diameter(cm)		
	December	February	Mean	December	February	Mean	December	February	Mean	December	February	Mean
Sand	12.20 ± 1.71^{c}	22.40 ± 1.25^{b}	17.30 ± 6.23^{AB}	1.0 ± 0.01^{a}	1.4 ± 0.25^{a}	1.2 ± 0.19^{A}	14.6 ± 3.74^{bc}	19.6 ± 1.29^{b}	17.1 ± 2.89^{A}	0.78 ± 0.03^{b}	0.72 ± 0.07^{b}	0.75 ± 0.05^{B}
Soil	8.60 ± 0.40^{c}	22.20 ± 0.66^{b}	15.40 ± 3.25^{B}	1.2 ± 0.2^{a}	1.8 ± 0.20^{a}	1.5 ± 0.24^{A}	11.4 ± 2.87^{c}	17.2 ± 0.86^{bc}	14.3 ± 2.42^{A}	0.77 ± 0.05^{b}	0.63 ± 0.06^{b}	0.70 ± 0.06^{B}
BRH	10.80 ± 1.83^{c}	28.00 ± 3.39^{a}	19.40 ± 4.35^{A}	1.0 ± 0.01^{a}	1.8 ± 0.20^{a}	1.4 ± 0.31^{A}	9.8 ± 2.87^{c}	27.6 ± 1.63^{a}	18.7 ± 4.74^{A}	0.76 ± 0.02^{b}	1.04 ± 0.08^{a}	0.90 ± 0.08^{A}
Mean	10.53 ± 3.39^{B}	24.20 ± 1.67^{A}		1.1 ± 0.12^{B}	1.7 ± 0.28^{A}		11.93 ± 3.09^{B}	21.47 ± 2.38^{A}		0.77 ± 0.03^{A}	0.80 ± 0.01^{A}	

Means for groups in homogeneous subsets are displayed. Based on observed means, n=5.
Superscripted lowercase letters depict the interaction effect while the uppercase letters depict the individual treatment effect. Means in the table followed by the same letter are not significantly different at p ? 0.05 according to DMRT.

base required for the rooting and further growth of cuttings. Furthermore, optimal temperature during February and March (18.7°C and 22.21°C mean temperature in consecutive years) marks the higher meristematic activity hence, higher endogenous auxin content that is required for rooting.

Burnt rice husk (BRH) contains higher quantities of essential nutrients such as nitrogen, phosphorus, potassium, and silicon compared to other media used, thus, improves the growth and development of the crop (Savvas *et al.,* 2002; Chaparro-Torres *et al.,* 2006; Kamenidou *et al.,* 2008; Karimi *et al.,* 2013; Oladele *et al.,* 2019). Release of micronutrients in BRH is more due to high ash content, hence, considered over soil and soil fertility wise (Mushtaq *et al.,* 2019). Along with porosity, low rotting property of BRH also reveal its efficacy as propagating media (Fanny *et al.,* 2020). Being rich in organic matter it is also responsible for maintaining neutral pH and possessing higher cation exchange capacity (CEC) (Major *et al.,* 2010; Munda *et al.,* 2016). The neutral pH of BRH also enhances nutrient availability to the cuttings. Furthermore, Thuja occidentalis, Cupressus macrocarpa, Hevea brasiliensis, and Vitellaria paradoxa exhibited better growth when cultivated in BRH (Ugese *et al.,* 2011; Ozdemir *et al.,* 2016; Salisu *et al.,* 2016). On the other hand, sand and soil were found to have lower nutrient content compared to BRH, which led to decreased plant growth as reported in Kalanchoe blossfeldiana (Kaur *et al.,* 2015).

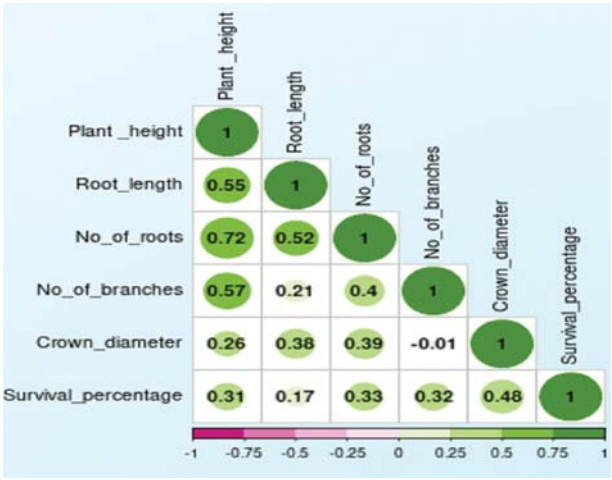
Rooting attributes : Root count is one of the major criteria that need to be observed critically. Nearly, 55.56 per cent higher number of roots were recorded in February (21.47 ± 2.38) planting over December (11.93 ± 3.09). However, mean variation among media was not found significant. In between interaction of media × planting time, maximum number of roots were recorded in BRH

Table 2: Correlation Matrix.

	Plant height	Root length	No of roots	No of branches	Crown diameter	Survival percentage
Plant height	1	0.546**	0.717***	0.565**	0.263	0.311
Root length	0.546**	1	0.522**	0.21	0.38*	0.167
No of roots	0.717***	0.522**	1	0.402*	0.39*	0.332
No of branches	0.565**	0.21	0.402*	1	-0.009	0.32
Crown diameter	0.263	0.38*	0.39*	-0.009	1	0.476**
Survival percentage	0.311	0.167	0.332	0.32	0.476**	1

*** Correlation is significant at 0.001 level (two tailed)
** Correlation is significant at 0.01 level (two tailed)
* Correlation is significant at 0.05 level (two tailed)

× February planting which was followed by sand × February planting (19.6 ± 1.29), soil × February (17.2 ± 0.86) and sand × December (14.6 ± 3.74) planting (Table 1).



Among root length, 41.28 per cent longer growth was observed in February month (5.33 ± 0.64 cm) over December (2.20 ± 0.53 cm) month planting (Fig. 2c). No significant variation was observed within media treatments (Fig. 2b). BRH × February produced longest root (8.6 ± 0.85 cm) among all treatments followed by Soil × February (4.8 ± 0.68 cm) and Sand × December (4.4 ± 1.94cm) (Fig. 2a). Variation of 4.6 per cent was recorded among treatments.

Crown diameter varies significantly among interaction and media treatment, however, not in case in planting time. Higher crown diameter was observed in BRH media (0.90 ± 0.08 cm) followed by sand (0.75 ± 0.05 cm) and soil (0.70 ± 0.06 cm). Interaction of BRH × February recorded widest crown diameter (1.04 ± 0.08 cm) which significantly higher than all other

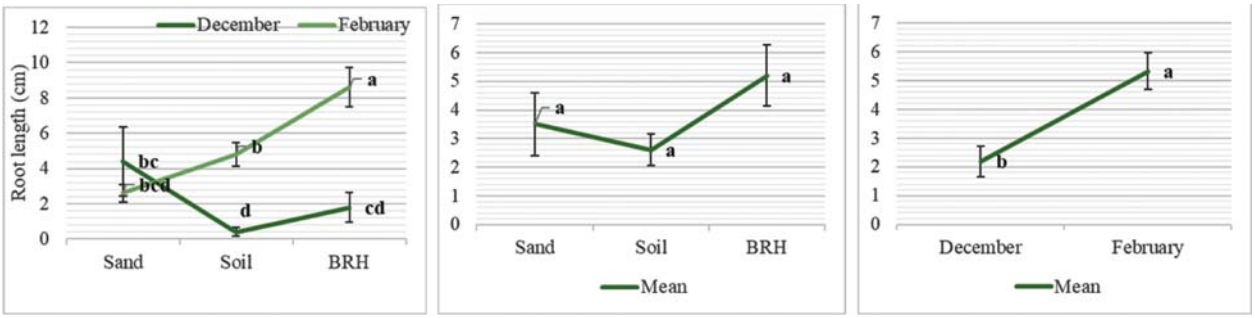


Fig. 2: Effect of planting time (c), rooting media (b) and interaction effect (a) on root length (cm) of *Plumeria rubra.*

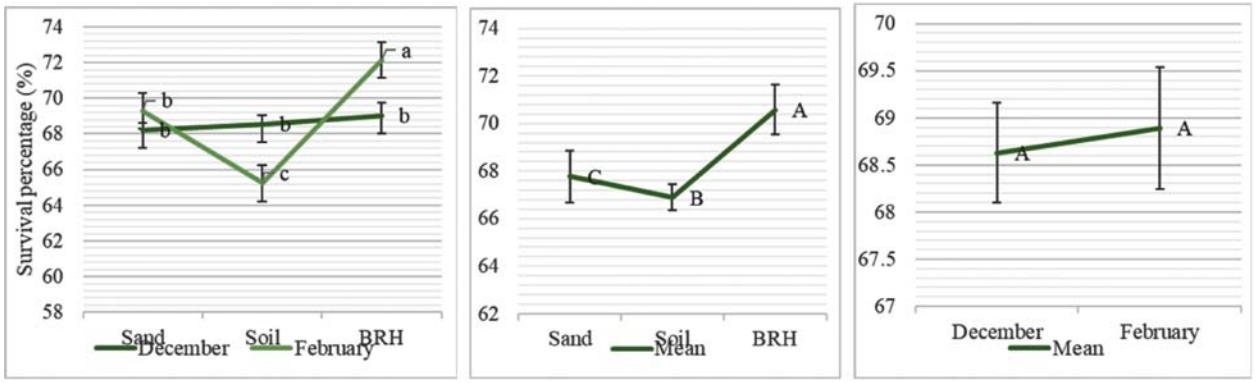


Fig. 3: Effect of planting time (c), rooting media (b) and interaction effect (a) on survival percentage of *Plumeria rubra.*

interaction. All other interactions were at par with each other with respect to crown diameter (Table 1).

Root growth is highly influenced by growing media characteristics as nutrient availability and retentivity, CEC, rhizospheric microbial growth, media coarseness and structure (York *et al.*, 2016). Regular expansion and division of roots are furthermore influenced by porosity. Studies show that BRH have high porosity which make suitable media for proliferation of plant roots in larger area and also reduce hard pan formation, in contrast with soil that holds low porosity (Jeon *et al.*, 2010; Varela *et al.*, 2013; Ephrem *et al.*, 2022). Over time, there is a notable rise in bulk density due to compaction and degradation of media, which consequently leads to a reduction in pore space and limits the amount of air reaching the roots (Chavez *et al.*, 2008; Papafotiou and Vegena, 2012). Burnt rice husk, known for its high total porosity (66-76 percent by volume) and water retention capacity (477-539 percent), which also plays a crucial role i.e., 477-539 percent (Islam *et al.*, 2002; Quintero *et al.*, 2009). High aeration provides gas exchange and optimal drainage to the crop hence considered excellent for root growth and development (Barrett *et al.*, 2016). The water holding capacity of BRH is also high over sand and soil that increase rhizospheric attributes of media for rooting. Hence, results in better root growth.

Propagating media and interaction of media × growing time significantly affected the survival per cent (Fig. 3a and Fig. 3b). Planting time however, didn't affected survival percentage (Fig. 3c). Among media, BRH produced maximum survival percentage (70.59 percent) followed by soil (66.89 percent) and sand (67.77 percent). BRH × February interaction recorded maximum survival of cuttings (72.14 ± 2.25 per cent) followed by sand × February (69.3 ± 1.36 per cent) which was at par with BRH × December (69.04 ± 2.25 per cent), Soil × December (68.54 ± 1.16 per cent), Sand × December (68.23 ± 0.91 per cent).

CONCLUSION

The study demonstrated that both planting time and propagation medium significantly influence the rooting and vegetative performance of Plumeria rubra cuttings. February emerged as the most favorable month for planting, likely due to its moderate temperature and humidity, which support root initiation and shoot development. Among the three-propagation media evaluated, Burnt Rice Husk (BRH) outperformed Soil and

Sand, showing superior results in terms of root length, plant height, number of roots, and survival percentage. The combination of February planting with BRH yielded the best outcomes, suggesting a practical, cost-effective method for enhancing Plumeria propagation under field conditions. These findings are especially beneficial for small-scale nursery growers, providing a sustainable and economical alternative to expensive commercial media without compromising plant health and growth

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(Received: April 2025 and Accepted: June 2025)