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Full Length Research Paper

Effect of ontogenic age on root and shoot development of *Tabebuia heterophylla* cuttings propagated in soilless culture

Yahya Awang[1]*, Ab Kahar Sandrang[2], Rosli Mohamad[1] and Ahmad Selamat[1]

[1]Deparment of Crop Science, Faculty of Agriculture, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia.
[2]Horticulture Research Centre, Malaysian Agricultural Research and Development Institute, P.O. Box 12301, 50774 Kuala Lumpur, Malaysia.

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A study was conducted to evaluate the root and shoot development in cuttings of *Tabebuia heterophylla* taken from varying ages of stock plants (1, 6, 18, 36 and 60 months). Cuttings obtained from the mother plants were rooted on perlite in saturated propagation chambers for 60 days. Generations of new roots and their subsequent growth, and the growth of new leaves from the cutting were reduced exponentially as the age of the stock plants increases, following a decay curve of $y=Ae^{-bx}$. In contrast, accumulation of leaf dry weight was highest in cuttings taken from six months old stock plants as explained by a modified Hoerl function of $y=A*b^{(1/x)*}x^{-c}$. The ability of juvenile cuttings to form roots was easier compared with older cuttings, and hence produces a larger root ball, these cuttings are expected to have a higher ability to survive.

Key words: Landscape tree, tecoma, rooting, vegetative propagation.

INTRODUCTION

Tabebuia heterophylla, commonly known as tecoma is a member of Bignoniaceae family, a popular landscape tree planted for its beautiful flowers. In the flowering season, the tree produces an effect resembling a cherry blossom tree. The tree is normally propagated by seeds and layering (Gilman and Watson, 1994), although production of seeds of most tropical trees is erratic and highly dependent on weather pattern (Ashton et al., 1988). Vegetative propagation of this plant is difficult (Whistler and Steele, 1999). However, successful and viability vegetative propagation technique for many horticultural plants is important, especially to obtain a true-to-type planting material, and continuous growth of new shoots from the stock plants is necessary to ensure unlimited supply of planting materials if the plants were to be propagated through cuttings. The rooting ability of a stem cutting is affected by many factors, such as the age of the stock plant. It decreases with increasing age of the stock plants. The use of ontogenetically younger or juvenile tissue is common practice to achieve a better organogenesis in the propagation of trees from cuttings (Nas et al., 1993; Yang and Ludders, 1993; Kibbler et al., 2004).

For example, the percentage of root formation of *Cinnamomum kanehirae* cuttings from 14 years old ortets was much lower than the rooting ability of terminal cuttings collected from newly formed sprouts (Kao and Huang, 1993), and that mango shoots culture was highly dependent on the source of explants with ontogenetically younger shoots (from 6 to 7 months old plants) compared with shoots collected from 12 to 14 years old of healthy and vigorous trees (Krishna et al., 2008). Poor organogenesis of young tissues collected from older trees is associated with high concentrations of certain compounds in the tissue, such as essential oils in *Backhousia citriodora* (Kibbler et al., 2002) and phenolic compounds, which is coupled with elevated activities of

*Corresponding author. E-mail: yahya_awg@putra.upm.edu.my. Tel: 603-89466017.

oxidative enzymes such as peroxidase (POD) and phenylalanine ammonia lyase (PAL) in olive and mango (Roussos and Pontikis, 2001; Krishna et al., 2008). In view of its high demand as an attractive landscape tree and its difficulty to propagate vegetatively, this study was conducted to evaluate the root and shoot development in cuttings of *T. heterophylla* taken from stock plants of varying age.

MATERIALS AND METHODS

Plant materials and experimental treatments

Rooting performance of cuttings from stock plants of five juvenility ages (1, 6, 18, 36 and 60 months) was evaluated. All stock plants were grown from seedlings in a soil-based medium (3:1 of loamy top soil and coconut coir dust). As a base fertilizer, the medium was incorporated with 5.0 g of a 15:15:15 compound fertilizer and 2.0 g of ground magnesium limestone (GML) for every liter of medium during the preparation. Stock plants for one and six months old were raised in plastic trays (25 x 30 x 10 cm) fewer than 50% shade and watered twice daily using overhead micro sprayer. No additional fertilizer was given to these plants as the plants grew healthily and did not show any nutrient deficiency. Stock plants for other juvenility ages were grown in 25 L pot in the open field and received 25 g/pot of a compound fertilizer (15:15:15) at every two months. The plants were watered daily unless on the rainy days. The cuttings were obtained by harvesting the terminal shoots with three to four nodes (6 to 8 cm long).

Generally, cuttings obtained from younger stock plants were shorter that those from older plants. Immediately after harvesting, the cuttings were put to root by inserting 1 cm deep, of the base of the cutting into the soilless medium comprising of perlite (8 cm deep) underlying with a layer of light expanded clay aggregates (LECA) in a propagation chamber. The propagation chamber was constructed using polystyrene boxes (55 x 43 x 30 cm), covered with polyethylene sheet to maintain the humid environment within. A 5 cm deep water reservoir was created and maintained at the bottom of the box by making a 1 cm hole at 5 cm above the base of each box for good air-water relationship atmosphere to exist in the rooting zone. Utilization of perlite as propagation media ensures good capillary rise from the reservoir into the propagation chamber, which was proven to be conducive in inducing the rooting of many tropical woody species (Awang et al., 2009). The chambers were placed under plastic nettings with 50% shade.

Data collection

The cuttings were checked for adventitious root number, root length, root dry weight, leaf number and leaf dry weight at day 60 after insertion. The root length was measured as the length of the longest three roots. Dry weights of roots and leaves produced by the cuttings were recorded after drying the respective plant parts for 72 h at 70°C.

Experimental design and data analysis

The experiment was conducted in a randomized complete block design (RCBD) with three replicates with each plot containing 10 cuttings. Data obtained were subjected to non-linear regression analyses using two different growth models: y=Ae-bx; for root number, root length, root dry weight and leaf number; and $y=A\times b^{(1/x)}\times X^{-c}$ for leaf dry weight.

RESULTS AND DISCUSSION

The effects of ontogenetic age or juvenility of stock plants on the root number, root length, root dry weight and leaf number generated by various types of cuttings can be explained satisfactorily by a logistic decay function:

$y=Ae^{-bx}$

Where, A and b are constants. Using such function, the root growth, as reflected by the number of roots (Figure 1), root length (Figure 2) and root dry weight (Figure 3) decreased exponentially as the ontogenic age of stock age increases. Within the period of study, change in root number, root length and root dry weight can be predicted by using their respective functions: $y=7.579e^{-0.133x}$ (R^2=0.99), $y=9.687e^{-0.177x}$ (R^2=0.99) and $y=0.676e^{-0.223x}$ (R^2=0.99). Only cuttings taken from one and six month old stock plants had generated roots successfully, while those taken from 18, 36 and 60 months old stock plants did not. Results recorded here are paralleled with the results reported earlier by other workers (Kiblbers et al., 2004; Mourao, 2008). The failure of the cuttings harvested from 18 months and older stock plants perhaps was associated with the higher concentration of endogenous rooting inhibitors (Kibblers et al., 2002). The influence of ontogenic age of stock plants on the survival of plant parts was also observed *in vitro* propagation. Working with mango, Krishna et al. (2008) reported that the survival duration of explants derived from newly emerged flush (5 to 7 days) collected from glasshouse grown seedlings (6 to 7 months old) was longer than similarly new flush collected from 12 to 14 years old, healthy stock plants.

Longer survival duration of explants collected from greenhouse grown seedlings was linked to a lower *in vitro* phenol exudation which could disturb the role of auxin in promoting root initiation. Higher root number, longer roots and more roots produced by cuttings harvested from juvenile plants are all desirable characteristics of good planting materials. Cuttings with such properties would form root balls in a shorter period of time once they are transferred into nursery containers, and perhaps would also have a higher tolerance level to cope with less favorable growing conditions. Jacobs et al. (2005) had demonstrated that a strong correlation existed between seedling's root volumes with the first year growth of red oak seedlings. The requirement of large root volume would be more critical if the seedlings are to be planted on low resource soils (Schreeg et al., 2005) as experienced by trees established in highly disturbed urban soils.

In contrast to rooting, all types of cuttings were able to generate new leaves, but the number of leaves decreases with the increasing age of stock plants (Figure 4). In general, the effect of ontogenic age of stock plants following a function of $y=8.501e^{-0.017x}$ (R^2=0.98) where, y

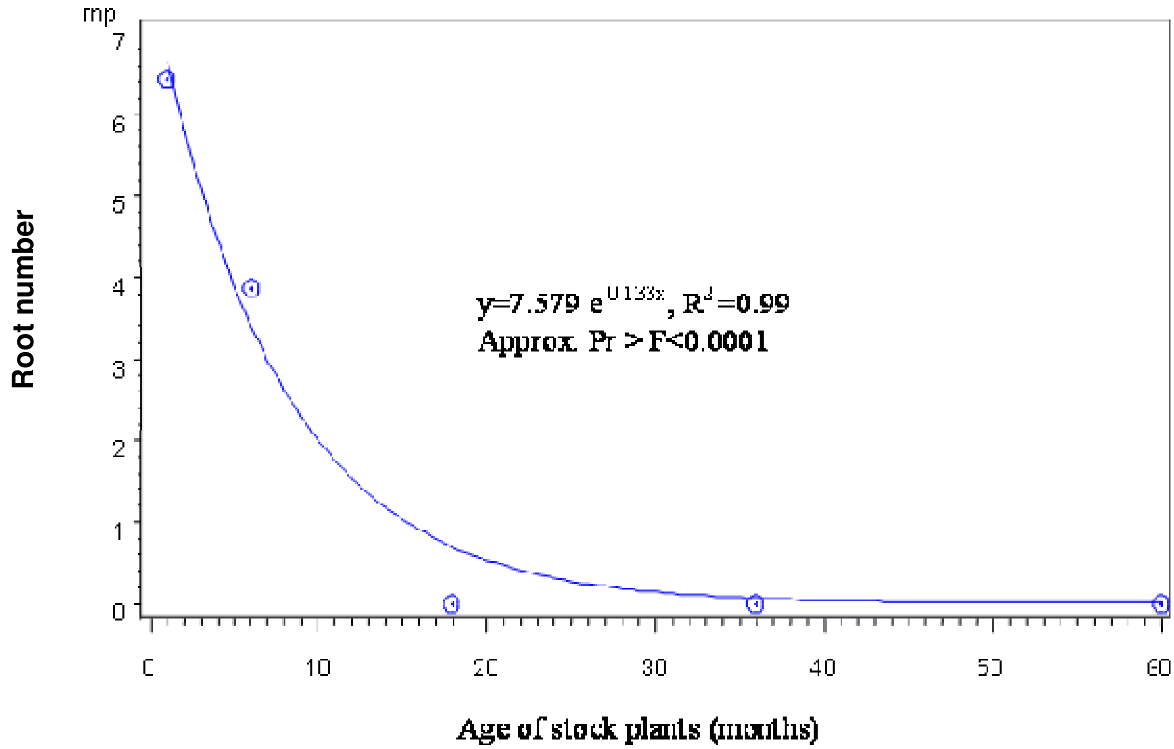

Figure 1. Number of roots produced by cuttings taken from different ontogenic age of stock plants.

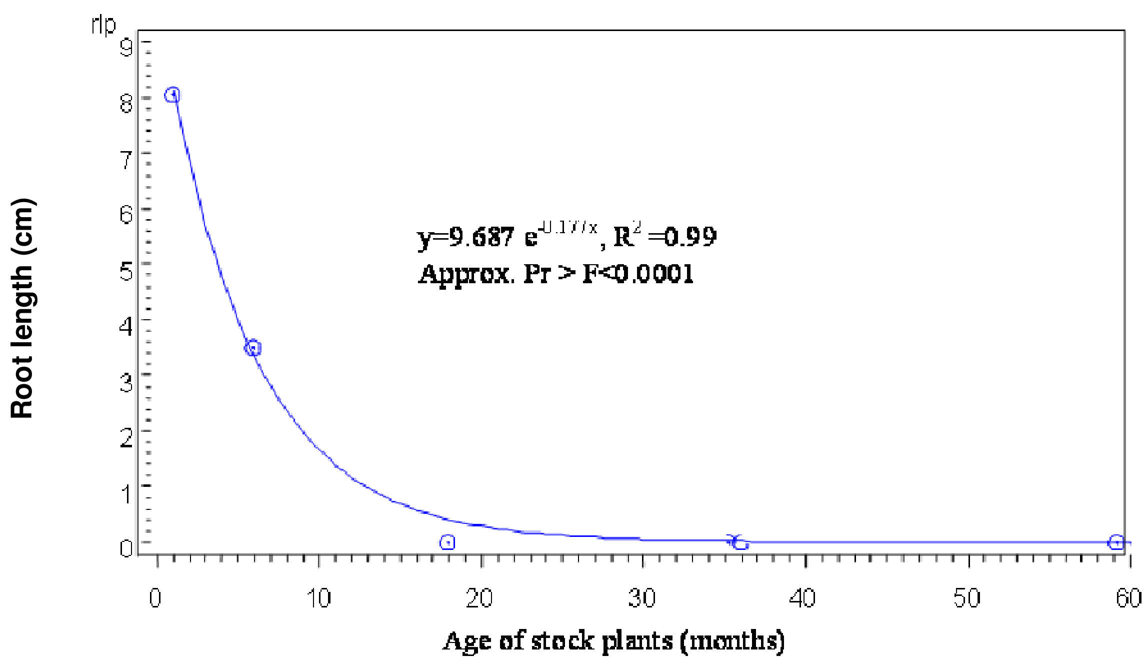

Figure 2. Length of roots produced by cuttings taken from different ontogenic age of stock plants.

and x are leaf number and age of stock plants. Based on the pattern of leaf generation of new leaves, the effects of ontogenic age of stock plants on leaf number by the cuttings can be divided into two groups: Cuttings from one month and six months old stock plants, and cuttings from 18 months and older stock plants. In general, juvenile cuttings (from one and six months old stock plants) produced 8.4 leaves/cutting while cuttings from

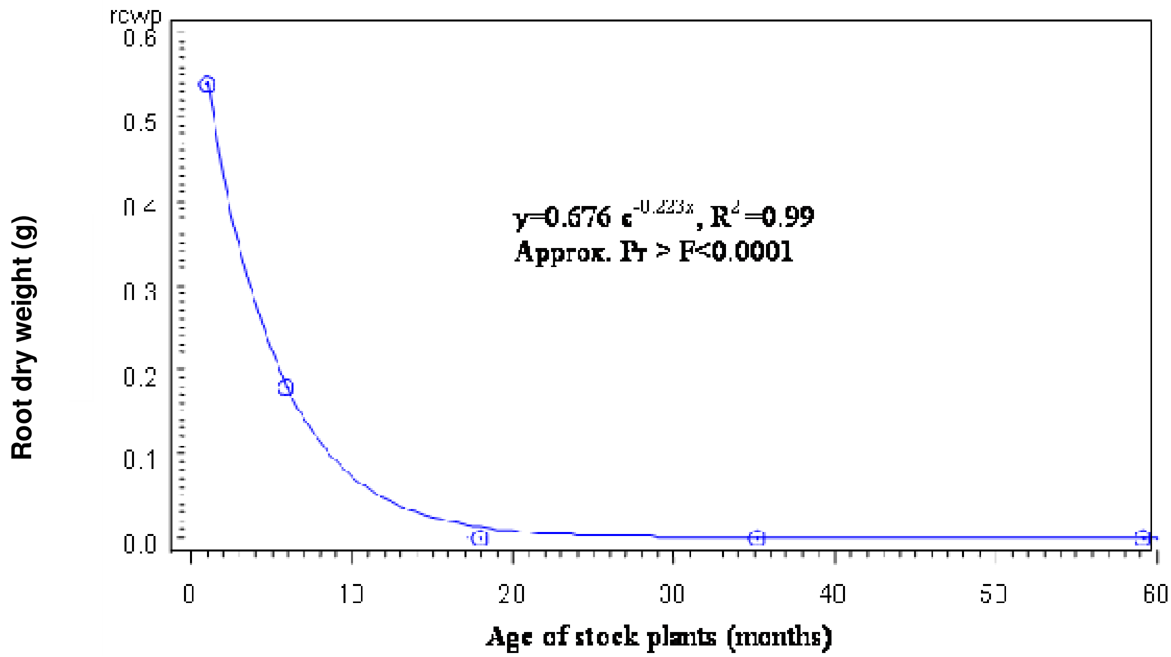

Figure 3. Dry weight of roots produced by cuttings taken from different ontogenic age of stock plants.

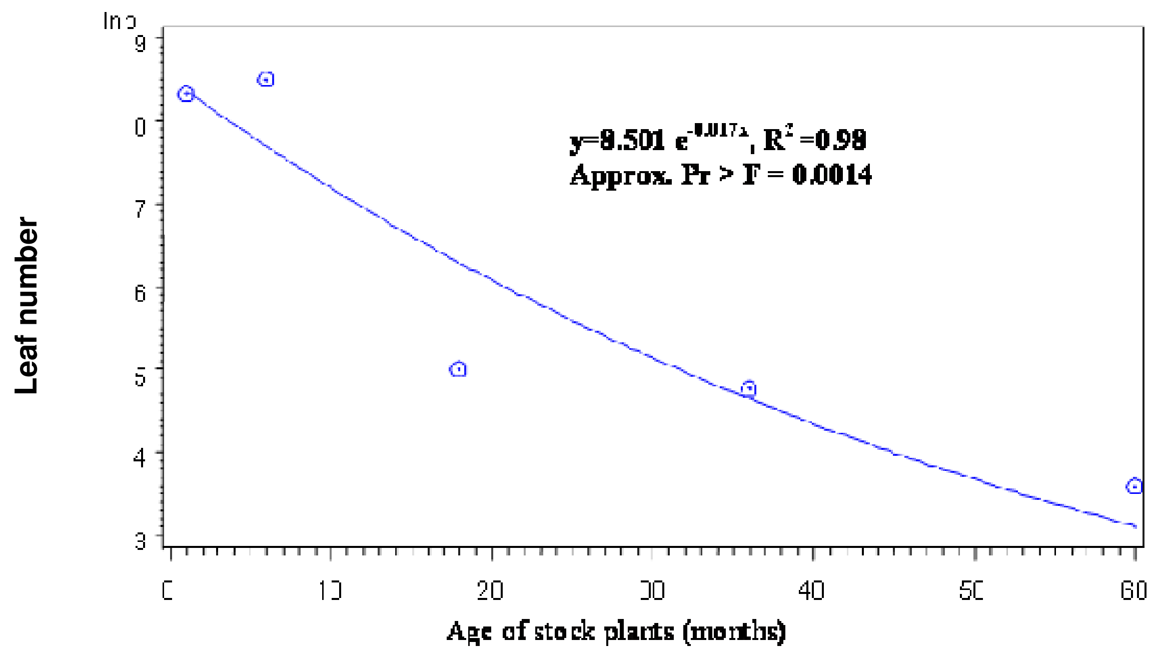

Figure 4. Number of leaves produced by cuttings taken from different ontogenic age of stock plants.

older plants produced 4.4 leaves/cutting. As all leaves were removed before the propagation process began and most of the new top growth occurred in leaves, leaf dry weight recorded in the study, represents the accumulated dry matter in shoot. Among the cuttings, leaf dry weight generated by cuttings taken from one month old stock plants were the smallest (Figure 5), while leaf dry weight from cuttings taken from six months old plants was the heaviest.

Overall, change pattern in leaf dry weight in response to the increasing age of stock plants can be explained by the function $y=2.598*0.329^{(1/x)}*x^{-0.106}$ (R^2=0.99). Lower leaf dry weight generated by juvenile cuttings despite having high number of leaves (Figure 5) indicated that

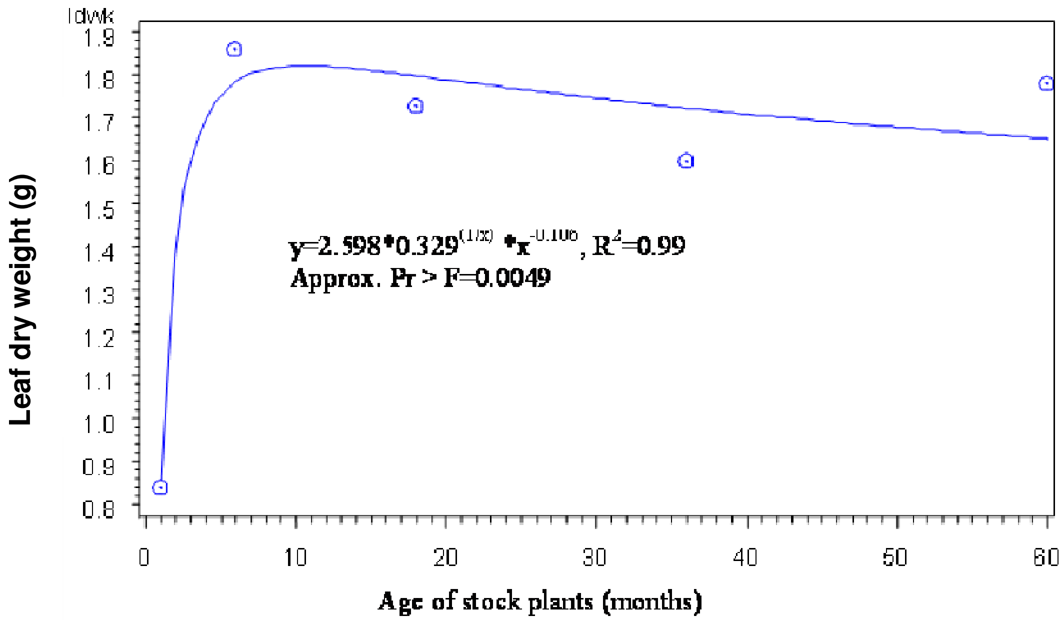

Figure 5. Leaf dry weight produced by cuttings taken from different ontogenic age of stock plants.

such cuttings had smaller leaves. However, with vigorous initial root growth of cuttings from juvenile stock plants, these leaves could be expected to develop rapidly once the cuttings are transferred into the nursery containers. Result in Figure 5, together with result shown in Figure 4 also indicated that cuttings from older stock plants have the ability to generate new leaves, and generally these leaves were larger than those of cuttings taken from juvenile plants as shown by their leaf weight. Generation of new leaves by cuttings from older plants could be attributable by sufficient food reserves stored in the bark of the cuttings that could have been used as energy sources to support leaf growth (Druege et al., 2004). However, the sustainability of these cuttings to survive is questionable as they did not produce any roots to ensure a continuous uptake of water and nutrients. Without roots, the cuttings would die off once all food reserves had diminished.

Conclusion

Juvenility influences early root and shoot development of *T. heterophylla* cuttings. The generation of new roots and its subsequent growth were reduced exponentially as the age of the stock plants increased. Rooting of *T. heterophylla* cuttings could be easily enhanced by using juvenile cuttings.

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