ノート (Note)

Productivity of root-cutting propagation of *Melia volkensii* Gürke: a case study in Japan

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Key words : clonal propagation, fast-growing tree, macro-propagation, tree breeding

Introduction

Melia volkensii Gürke is a fast-growing tree species endemic to the drylands of eastern Africa, and its high-quality timber is used for construction and furniture (Muok et al. 2010). Owing to its high economic value, the Kenya Forestry Research Institute, with support from the Japan International Cooperation Agency and the Forest Tree Breeding Center of Japan, has implemented breeding projects for this tree species since 2012. The projects have selected candidate plus trees and established clonal seed orchards with them. Although these projects have increased seed production from the improved trees, a majority of saplings for afforestation have been grown from seeds collected from unimproved sources (Kariuki et al. 2021a). Seeds collected from improved *M. volkensii* are still scarce. Therefore, more mother trees, propagated clonally from improved individuals, are needed. Grafting is common in Kenya as a macro-propagation method for *M. volkensii*; however, it requires special techniques and effort (Kamondo et al. 2016). Stem cutting propagation is an easier method but is not feasible for *M. volkensii* (Kariuki et al. 2021a). A simpler and more practical macro-propagation method for *M. volkensii* is root-cutting propagation (Hanaoka et al. 2016). Hanaoka et al. (2016) proposed practical criteria that indicated a suitable root material size for propagation. Furumoto (2022) reported the growth of saplings propagated by the root-cutting method. The root materials used in previous studies were collected from small potted saplings. If we conduct root-cutting propagation in practical breeding projects, we have to collect root materials from improved trees with a sufficient size to pass statistical tests. Digging out roots from such large trees may require some effort. If small clonal saplings of improved individuals are available as donors for the propagation, such effort can be minimized. Therefore, we examined whether we could use small clonal saplings propagated by the root-cutting method as donors for subsequent propagation.

Materials and Methods

On June 4, 2020, we performed root-cutting propagation using 30 *M. volkensii* saplings as donors (Furumoto 2022) and cultivated the donors and 38 saplings propagated by root cutting in a wind-protected greenhouse with natural light and temperature at the Iriomote Tropical Tree Breeding Technical Garden on Iriomote Island, Okinawa Prefecture, Japan (24°19′N, 123°54′E). Thirty donors were cultivated in three types of planting pots, consisting of ten pots each. The types of pots were 23.1 × 25.5 cm Air-pot® (The Caledonian Tree Co. Ltd., U.K.) designed for good root structures (Single and Single 2010), 24 × 21 cm Slit Pot (Kaneya Co., Ltd., Aichi, Japan) with slits and ribs at the bottom to prevent root circling, and 24 × 24 cm polyethylene pots (Tokai Kasei, Gifu, Japan) without a mechanism to avoid root deformities. The saplings were cultivated in 9 × 30 cm polyethylene pots (Tokai Kasei, Gifu, Japan) without any structure to prevent strangulated roots. We used a new medium consisting of commercial gardening soil (Oishi Corporation, Fukuoka, Japan) mixed with an equal volume of pumice (Setogahara Kaen, Gunma, Japan) as the cultivation medium for all planting pot types.

On December 10, 2021, we dug up all donors and saplings from the pots and collected root materials meeting the criteria of Furumoto (2022), which simplified those of Hanaoka et al. (2016). To compare the number of collected materials among cultivation conditions, we performed Tukey's HSD multiple

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Melia volkensii Gürke の根ざし増殖生産性：日本での試行

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comparison test using R ver. 4.1.2. (R Core Team 2021) with the multcomp library ver. 1.4.18. (Hothorn et al. 2008).

Results

All donors and saplings survived for one and a half years. At the end of the cultivation period, the average heights (mean ± standard deviation; SD) were 69.1 ± 19.2 cm in the donors and 51.7 ± 15.0 cm in the saplings.

Figure 1 shows the mean, SD, and number of root materials collected under the four cultivation conditions. The means and SDs of the number of collected root materials were 2.5 ± 1.8 in the Air-Pot, 1.7 ± 0.8 in the Slit Pot, 2.2 ± 1.2 in the 24 × 24 cm polyethylene pot, and 2.2 ± 0.8 in the 9 × 30 cm polyethylene pot. The mean numbers did not differ significantly among the groups (p-values ranged from 0.351 to 1.000). The overall mean ± SD was 2.1 ± 1.1. The maximum number of collected materials was six in the Air-Pot. Donors with no root material meeting the criteria were observed in all three pot types. The saplings propagated by root cutting produced at least one root material sample.

Discussion

After the root-cutting propagation, the donors and saplings were cultivated for one and a half years. They produced a mean of 2.1 root materials for further root cutting.

The number of root materials collected from the re-grown donors and the saplings propagated by root cutting did not differ significantly among the four types of planting pots. It was clear that all types of pots examined in this trial were suitable for cultivation to repeatedly collect roots for root-cutting propagation.

The productivity of root-cutting propagation of *M. volkensii* can be expressed as

$$N = D \times R \times Fs + D \times Fd$$
$$= D \times (R \times Fs + Fd),$$

where N is the number of intact clonal saplings produced in one root-cutting propagation; D is the number of donors; R is the mean number of root materials collected from each donor; and Fs and Fd are the frequencies of intact saplings grown from root materials and surviving donors after regrowth, respectively. R and Fd were approximately 2 and 1.0 in this trial, respectively, and Fs was reported as 0.45 in a previous trial (Furumoto 2022).

For instance, if 10 root materials are used in the first root-cutting propagation, then approximately five roots may grow to intact saplings (10 roots × 0.45). These clonal saplings can be

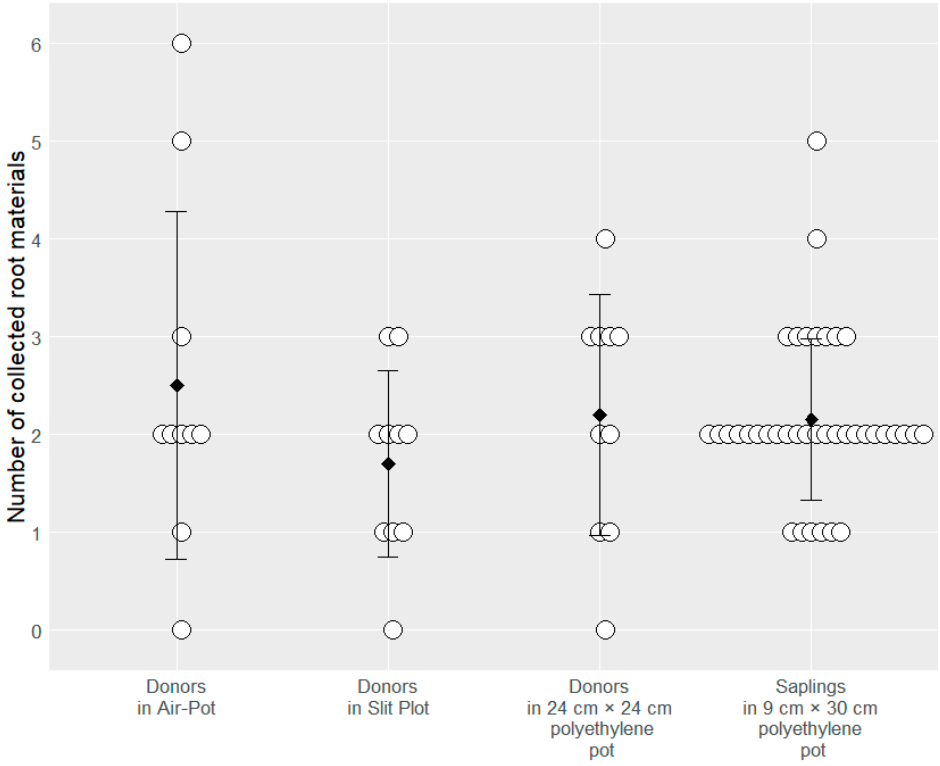

Fig. 1. Number of root materials of *Melia volkensii* collected from the donors and saplings one and a half years after cultivation following root-cutting propagation in Iriomote Island, Japan. Open circles and filled diamonds indicate the number and mean numbers of each of the collected materials, respectively. Error bars indicate the standard deviations.

used as donors for the following propagation. If five saplings are used as donors, then approximately 10 sprouted plants, including the re-grown donors, may be available (5 donors × 2 roots × 0.45 + 5 donors × 1.00, or 5 donors × 1.9). If all the 10 plants are used as donors for the next propagation, then 19 intact clonal saplings may grow (10 donors × 1.9).

It took one and a half years to grow clonal saplings in the present trial conducted on Iriomote Island in Japan, whereas the propagation scheme with grafting in Kenya took approximately ten months to grow saplings for clonal seed orchards of *M. volkensii* (Kariuki et al. 2021b). Compared with the grafting method in Kenya, the root-cutting method in this trial may have the disadvantage of a longer cultivation period. However, root-cutting propagation has the advantage that it neither requires special techniques and equipment nor does it require rootstocks, which may produce incongruous growth or unnecessary shoots. As Furumoto (2022) mentioned, the climatic conditions on Iriomote Island seem to be unsuitable for the growth of *M. volkensii*. Under more suitable conditions, clonal saplings propagated by root cutting are expected to grow larger in a shorter period, and the frequency of intact clonal saplings is also expected to be higher. Further trials to examine the practical productivity of root-cutting propagation under suitable conditions, such as in Kenya, are necessary.

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