EVALUATING THE GROWTH PERFORMACE OF TISSUE CULTURED AND SEED PROPAGATED *ENDOSPERMUM DIADENUM* (SESENDOK) TREES

Keeren Sundara-Rajoo
Plant Improvement Programme of Forest Biotechnology Division,
Forest Research Institute Malaysia (FRIM),
Kepong 52109, Selangor, Malaysia

Mohd-Zaki Abdullah
Plant Improvement Programme of Forest Biotechnology Division,
Forest Research Institute Malaysia (FRIM),
Kepong 52109, Selangor, Malaysia

Nor-Fadilah Wook
Plant Improvement Programme of Forest Biotechnology Division,
Forest Research Institute Malaysia (FRIM),
Kepong 52109, Selangor, Malaysia

Siti-Salwana Hashim
Plant Improvement Programme of Forest Biotechnology Division,
Forest Research Institute Malaysia (FRIM),
Kepong 52109, Selangor, Malaysia

Ahmad-Fauzi Mohd-Shariff
Plant Improvement Programme of Forest Biotechnology Division,
Forest Research Institute Malaysia (FRIM),
Kepong 52109, Selangor, Malaysia

ABSTRACT

Endospermum diadenum (synonym: Endospermum malaccense) is a medium to large, fast-growing and light-demanding species. Commonly known in Malaysia as Sesendok, its light wood is used for general purposes such as making clogs, matches, toothpicks, toys, disposable chopsticks and other daily used items. Due to the desirable characteristics of Sesendok, FRIM has listed it as one of the 8 potential indigenous species to be planted in forest plantations. To achieve this, there needs to be a continuous supply of good quality planting material of Sesendok. Although the species flowers yearly, sometimes even twice a year in Malaysia, obtaining wild seeds of E. diadenum has proven to be difficult. This is due to the seed of E. diadenum being heavily predated by insects. Moreover, the seedlings have also been found to be very fragile and can easily be dehydrated due to having fewer root hairs. To overcome this, FRIM has conducted studies on the propagation techniques in order to produce good planting materials of Sesendok. Therefore, this study aims to compare the survivability and growth performance of Sesendok trees propagated from seeds and tissue culture. The seeds of Sesendok were collected from selected mother trees, while explants from nodal segment parts were cultured via tissue culture technique. The selected mother trees were originated from Ulu Tranum Forest Reserve (FR) and Lentang FR. The study site was established in February 2016 at FRIM Research Station, Selandar, Melaka. The trial plot covers an area of 0.48ha with a planting distance of 4m X 3m. Growth data were assessed after 28-months of planting. Based on the growth parameters and survival rate, propagation via tissue culture is the best technique to be used for future forest replanting and E. diadenum tree improvement programmes. After 28-months of planting, tissue culture trees recorded significantly higher diameter at breast height (6.7cm±1.39) compared to seed trees (6.51cm±1.97). Tissue culture trees also had better survival rates (75.1%) than seed trees (60.5%). However, seed trees recorded significantly higher height (6.51m±1.97) compared to tissue culture trees (5.58m±1.21). This could be attributed to tissue culture trees having a significantly lower height at planting (0.72m±0.23), compared to seed trees (1.05m±0.35). Nevertheless, based on height increment rates, tissue culture trees had significantly higher height increment after 28-months of planting (1.4m±0.04) compared to seed trees (1.34m±0.1). Further continuous evaluation is required in later years to assess both quantitative and qualitative parameters of all progenies.

Key words: Endospermum diadenum, propagation, tissue culture, seeds, variation

INTRODUCTION

The timber industry has spearheaded the Malaysian economy for almost a century (Awang et al., 2007). Starting with only primary processing for the production of sawn timber and veneer/plywood in the mid-1940s, the country's timber industry has now expanded into secondary and tertiary processing; For the production and export of mouldings, laminated timber, furniture, flooring and other timber products (Lewis and Davis, 2015). This growth is caused by the steadily increasing export value for timber and timber products across the globe (Soerianegara and Lemmens, 1993). The Malaysian government has enacted policies to develop "work forests", which are forest plantations that are able to continuously supply forest products in a sustainable manner. Hence, it has become a core objective of Forest Research Institute Malaysia (FRIM) to conduct research activities for the development and genetic improvement of tree species to be planted in these forest plantations. One such species is Endospermum diadenum.

Endospermum diadenum (synonym: Endospermum malaccense) is a medium to large, fast-growing and light-demanding species, making it an ideal tree to be planted in degraded forests and forest plantations (Hassan et al., 2009; Ahmad, 2014). Commonly known in Malaysia as Sesendok, its light wood is used for general purposes such as making clogs, matches, toothpicks, toys, disposable chopsticks and other daily used items, making it a lucrative timber product in the forest industry (Taharin et al., 2015). Bioprospecting of Sesendok's non-timber part (leaves in particular) to be used as an active ingredient for high value herbal/pharmaceutical products has also been carried out (Ahmad, 2014). The tree can grow up to 40 meters and achieve 3-meter dbh and is considered to be a good alternative for rubberwood (Ismaili et al., 2017).

Due to the desirable characteristics of Sesendok, FRIM has listed it as one of the 8 potential indigenous species to be planted in forest plantations. To achieve this, there needs to be a continuous supply of good quality planting material of Sesendok. Although the species flowers yearly, sometimes even twice a year in Malaysia, obtaining wild seeds of E. diadenum has proven to be difficult. This is due to the seed of E. diadenum being heavily predated by insects (Ang, 1997). Moreover, the seedlings have also been found to be very fragile and can easily be dehydrated due to having fewer root hairs. Therefore, FRIM has conducted studies on the production of good planting materials of Sesendok. This includes obtaining seeds from superior mother trees and the development of clones.

The collection and development of good quality planting materials of Sesendok need to be managed carefully in order to ensure their value is preserved for both conservation and forest replanting purposes. Therefore, this study aims to compare the survivability and growth performance between seeds and clones of Endospermum diadenum. The survivability and growth performance of Sesendok seeds and clones of E. diadenum were evaluated and compared in a twenty-eight-month field trial, at Selandar, Melaka (FRIM Selandar Research Station Selandar).

RESULTS AND DISCUSSION

As shown in Table 1, seed propagated E. diadenum trees had better growth performance in terms of overall height. The height of E. diadenum at 28-MAP was 6.51m±1.97 for seed propagated trees and 5.58m±1.21 for tissue culture. However, the dbh at 28-MAP was better for tissue culture trees (6.47cm±2.26) compared to seed trees (6.47cm±2.26).

Studies have found that E. diadenum trees growth rates are affected by weather patterns, whereby the trees showed decreasing growth increment during the peak of dry seasons and wet seasons (Wang and Hamzah, 2019). In other words, E. diadenum trees grew best when there wasn't a shortage or an overabundance of rainfall. This is a common characteristic in tropical forest trees (Schippers et al., 2015). Thus, climatic conditions could've affected the growth rate of E. diadenum trees in this study. Regardless, the data showed that tissue culture trees had the best growth performance in terms of survival rate (Table 1) and growth performance (Table 2).

Table 1: Height, dbh and survival rates of *E. diadenum* (tissue culture and seed trees).

Number of months after planting	Tissue culture			Seeds		
	Survival rate	Height (m)	Dbh (cm)	Survival rate	Height (m)	Dbh (cm)
Zero (At planting) (0-MAP)	100%	0.72±0.23	-	100%	1.05±0.35*	-
Seven months (7-MAP)	85.6%	1.58±0.54	-	76%	2.11±0.95*	-
Eleven months (11-MAP)	78.6%	2.52±0.68	2.89±0.81	69%	3.24±1.18*	3.18±1.21 *
Twenty-one months (21-MAP)	76.3%	4.23±1.08	4.77±1.18	62.8%	5.11±1.53*	5.08±.1.72 *
Twenty-eight months (28-MAP)	75.1%	5.58±1.21	6.7±1.39*	60.5%	6.51±1.97*	6.47±2.26

Data presented as mean±SE (standard error),
*significantly higher at $p < 0.05$

Table 2: Height (m) and dbh (cm) increment rate of *E. diadenum* (tissue culture and seed trees).

Number of months after planting	Tissue culture		Seeds	
	Height (m)	Diameter (cm)	Height (m)	Diameter (cm)
Seven months (7-MAP)	0.85±0.03	-	0.9±0.07*	-
Eleven months (11-MAP)	0.9±0.0	-	1.06±0.05*	-
Twenty-one months (21-MAP)	1.7±0.06	2.1±0.15	1.88±0.08	1.9±0.09
Twenty-eight months (28-MAP)	1.4±0.04*	2.12±0.2*	1.34±0.1	1.45±0.7

Data presented as mean±SE (standard error),
*significantly higher at $p < 0.05$

CONCLUSION

This study found that tissue culture propagation method have the potential to be used for future mass production of planting materials for forest replanting and E. diadenum further tree improvement programmes. Even though tissue culture trees' growth developed a little late than seed trees, but the growth was more uniform and survival rates are better. After 28-MAP, tissue culture trees recorded the highest increment in terms of height (1.4m±0.04) and dbh (2.12cm±0.2), and also had better survival rates (75.1%) when compared to seed trees (60.5%).

Acknowledgements: The authors would like to thank the Malaysian federal government, for funding this research under the 11th Malaysia Plan (RMK-11). We would also like to thank the Kelantan state government for allocating the study site and supporting this research.

REFERENCES

1. Abdullah, S.M. 2019. Jeli safest place in Kelantan. New Strait Times. Retrieve from https://www.nst.com.my/news/nation/2019/03/471658/jeli-safest-place-kelantan.
2. Ahmad, Z. 2014. Research for effective plantation forestry. FRIM in Focus. Pp 2-3
3. Ang LH. 1991. Effects of open and under planting on early survival and growth of Endospermum malaccense (sesendok), Alstonia angustiloba (pulai) and Shorea parvifolia (meranti sarang punai). Journal of Tropical Forest Science. 3(4): 380-384.
4. Awang, N.A.G., Norini, H., Khamurudin, M.N., Ahmad A.N., and Thorsen, B.J. (2007) Economic valuation of timber resources in Ayer Hitam Forest Reserve, Puchong, Selangor. Pertanika J Trop Agric Sci 30:83–9
5. Barwick, M. Tropical and Subtropical Trees - A Worldwide Encyclopaedic Guide. Thames & Hudson, London. ISBN: 0-500-51181-0.
6. Fah, L.Y., Mohammad, A. and Chung, A.Y.C. 2008. A guide to plantation forestry in Sabah. Sabah Forest Record, Malaysia. ISBN: 978-983-42418-3-4
7. Hassan, A., Mohamad, A., Wahab, R., and Mojiol, A.R. 2009. Growth increments of indigenous species planted in secondary forest area. Res J For 3 (1): 23-28
8. Heryati, Y., Belawan, D., Abdu, A., Mahat, M.N., Abdul-Hamid, H., and Majid, N.M. 2011. Growth Performance and Biomass Accumulation of a Khaya ivorensis Plantation in three Soil Series of Ultisols. American Journal of Agricultural and Biological Sciences, 6(1), 33–44. doi:10.3844/ajabssp.2011.33.44
9. Ismaili, G., Roslani, R., Rahim, K.K.A., Duju, A., Ismaili, Z., Openg, I., and Ilias, M.N. (2017). Behaviour of Strength Properties of Fast-Growing Endospermum diadenum Species at Different Distance from the Vortex. Materials Science. 23. 10.5755/j01.ms.23.3.16642.
10. Jusoh, I., Suteh, J.K. and Adam, N.S. 2017. Growth and Yield of Acacia mangium based on permanent sampling plots in a plantation. Transactions on Science and Technology 4(4): 513-518
11. Karyati, Ipor, I.B., Jusoh, I., and Wasli, M.E. 2017. The diameter increment of selected tree species in a secondary tropical forest in Sarawak, Malaysia. Biodiversitas 18(1): 304-311.
12. Krisnawati, H., Varis, E., Kallio, M., and Kanninen, M. 2011. Paraserianthes falcatari (L.) Nielsen; Ecology, silviculture and productivity. CIFOR, Bogor, Indonesia. ISBN 978-602-8693-41-7.
13. Lee, S.S. 2004. Diseases and potential threats to Acacia mangium plantations in Malaysia. Unasylva, 217(55): 31-35.
14. Lewis, R.A., and Davis, S.R. (2015). Forest certification, institutional capacity, and learning: An analysis of the impacts of the Malaysian Timber Certification Scheme. Forest Policy and Economics. 52: 18-26.
15. Rahman, K.A., Afizzul, M.M., Niiyama, K., Lida, S., Kimura, K., Sato, T., Nurhajar, Z.S., Samsudin, M., Ismail, H. and Azizi, R. 2016. Predicting annual stem diameter increment of major tree species in mixed hill dipterocarp forest with consideration on tree and stand level effects. Journal of Tropical Forest Science 28: 359-368.

16. Schippers, P., Sterck, F., Vlam, M., and Zuidema, P.A. (2015) Tree growth variation in the tropical forest: understanding effects of temperature, rainfall and CO2. Glob Chang Biol 21:2749–2761
17. Soerianegara I, and Lemmens RHMJ (eds.). 1993. Plant Resources of South-East Asia. No. 5(1): Timber trees: major commercial timbers. Backhuys Publishers, Leiden.
18. Taharin, K.A., Abudllah, M.Z., Hashim, S.S., Shariff, A.F.M. and Ariff, F.F.M. 2015. Ex-situ Conservation of Endospermum malaccense (Sesendok): Tree Selection, Wilding Handling and Seed Germination. J. Trop. Resour. Sustain. Sci. 3: 39-42
19. Wang, K.H. and Hamzah, M.Z. 2019. Annual wood formation of tropical pioneer species related to stem diameters. Journal of wood science, 65:22.
20. Zuhaidi, Y.A. 2013. Crown diameter prediction model for plantation-grown Neolamarckia cadamba. Journal of tropical forest science, 25(4): 446-453.