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Vegetative Propagation of Five Local Cultivars of Malay Apple (*Syzygium malaccense spp.*) in Ternate Island

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***Abstract*— The characteristics of cuttings of five cultivars of local malay apple (*Syzygium malaccense* L.) was studied in Ternate Island, Indonesia. Hardwood cuttings of malay apple were planted in two combinations of media and hormone treatments. During 5 months experiment, can be found that hardwood cutting of malay apple with top soil+ sand and NAA 1000 ppm had the best performance in producing shoots and roots for cuttings of malay apple in a short period. Although, each of these cultivars has different performance to rooting and shooting, but its can be propagated by cuttings. Therefore, the result of this research is expected to contribute for conservation of malay apple as a source of germplasm for further research and commercialization of malay apple as new potential fruit in the international market demand.**

***Keywords*— cultivar, conservation, malay apple, cuttings, hormone, media.**

I. INTRODUCTION

Conservation of endangered species is one of the popular issues in the recent world as their existence appeared to be related to environmental change. This issue is not only related to the change of climate that can cause disappearance some of species, but also related to germ plasm beneficial for developing varieties resistant to pathogens like viruses and bacteria, and as sources of medical drugs from extraction of their components and as new sources of food for people to augment to reduce malnutrition and starvation.

Many countries conserve their natural resources that have beneficial values for the nation including biodiversity of many kind of animals and plants. As one of the large island countries in the world that consists of almost 17,508 islands [1] Indonesia becomes a home for diverse of animals and plants that has not been explorated much yet [2]. The biodiversity is important not only in the ocean but also in the forest ecosystems.

In the past, there was one place in Indonesia that was interesting to many scientific experts from Europe ([3],[20],[23]). North Moluccas Province was one of the popular regions in Indonesia for traders from all around the world in the past and is known as the Spice Island [23], including Bacan, Makian, Moti, Ternate, and Tidore. Since 618 BC until 906 BC in Thang Dynasty, the traders from China have visited North Moluccas and Timor to buy spices and sandal wood [20].

However, many traders from Middle East, South Asia and Europe came to trade spices such as clove, nutmeg and cinnamon [23] from these islands. But not much people in the world including present scientists knew how important this region is with respect to biological sciences over the world by contribution of Alfred Russel Wallace (1989), The Malay Archipelago [3] and George Everhard Rumpf (Rumphius) (1627-1702), Herbarium Amboinense (Rumphius, 1743) and Amboinische Raritaten-kamer (Rumphius, 1705) who conducted their observations in these islands [4]. Alfred Russel Wallace contributed to Darwin's thinking about evolution while the Rumphius contributed to binomial classification of Linnaeus. Some of collections of botanical and zoological collections of Moluccas and Nusa Tenggara are located in the largest museums of Europe, especially in the Netherlands, Germany, Switzerland and Italy [20].

The biodiversity of North Moluccas island becomes a major importance for present situation while still there are many confusions among scientists about origin of some species. One of the important families that has been noticed by researchers is the Myrtaceae family, which is not due to its oldest nature of cloves (Syzigium aromaticum) [11] in the world (±350 years old), but due to the species of malay apple [(Syzygium malaccense), (gora rica/Ternate)], wax jambo

[(Syzygium samarangense), (gora/Ternate)] and jambul [(Syzygium cumini), (jambulang/Ternate)] which are needed to be protected.

Moreover, these islands became the origin of canary [(Canarium spp.), (kenari/Ternate)] [20], and many other fruits such as bananas (Musa spp.), mangosteen [(Garcinia mangostana), (mangosteen/Ternate)], duku (Lansium domesticum var. duku), langsat (Lansium domesticum var. domesticum) and durian (Durio zibethinus), etc. that still exist in the agroforestry systems and natural forests with no disturbance. However, some forests in these islands have been threatened for existence due to mining activities in various places, so that different plant species in such locations are currently threatened. This necessitates the protection of such species for future with respect to their food values and germplasm and also protecting biodiversity.

Although malay apple (Syzygium malaccense) is one of the tropical fruits ([17], [28]) which is still not popular compared to durian, mangosteen and rambutan, etc., this fruit is delicious ([17],[28]) more preferred than wax jambu. Commonly, these fruits are dispersed and harvested in forests, but have not intensively been cultivated until now. One of the main reasons is the lack of knowledge of its propagation in mass scale. One of the interesting facts is that not too much published materials of this species are available, although it has many varieties grown in North Moluccas islands. If compared with other sources in other Pasific countries, there are more than two kinds of malay apple in Ternate Island which are growing naturally in the forest, but because of logging of trees, there is a chance that it may not be able to find some of these varieties again.

The main constraint in protecting malay apple is the lack of knowledge of propagation and effective propagation techniques, which hinders production of planting materials for expansion of its cultivation. Eventhough, the propagation techniques vary and diverse in agriculture ([8], [15], [21], [22], [26]), these techniques have not been tried out and used for malay apple. There are some constraints and problems for improving varieties of malay apple:

- long juvenile period of trees [28],
- some fruits not bearing seeds [28],
- rapid loss of seed viability and seed rot,
- typical tallness of trees that imposes difficulties to examine the maturity stage of fruits and hence to control the quality and harvest stage at the right maturity stage,
- the limited conservation of plants mainly growing in the forests and endangered due to rapid deforestation and lack of public knowledge of the commercial value of forest crops and products that can be harvested as NTFPs,
- commercialization of only a limited number of tropical fruit species which prevents the attention on other crops with food and nutrition values, like malay apple.

This study was conducted to determine the effect of variety, potting media and plant growth regulator for promoting root and shoot production of malay apple cuttings in order to domesticate and expand its cultivation.

No country is yet commercially producing malay apple like other popular tropical fruits for the international trade. Identification of appropriate cutting propagation techniques would enhance the possibilities for developing and screening new hybrids with high food and market values. This may generate opportunities for introducing malay apple to rural farming systems and increasing farmers' incomes, like other popular fruit species and, by which improvement of exportation to international markets.

Fig. 1. Five local cultivars of malay apple was used in this research, above : Jati, Bottle, Bagea, below : Dark Purple and Red Circle (from left to right)

II. Materials and Methods

This research was conducted in Ternate island in North Maluku, Indonesia. The experimental site was located at Sasa village about 0045' N latitude and longitude 1270 19' East with elevation around 11-13 meters above mean sea level and at a distance of approximately 500 m from shore line. Ternate Island is one of the 1474 islands in North Maluku Province [1] located in western part of Halmahera island. Geographical position of Ternate island is 1260 20'-1280 05' E longitude and 0050' -2010' N latitude with altitute range of 0- 2700 meters above mean sea level, where the peak of Ternate island is Gamalama mountain, an active volcano [6] that contributes to soil fertility and land productivity of this island.

The treatments were composed by 5 x 2 x 2 factorial combination of variety, type of potting media and type of rooting hormone. The five varieties were malay apple jati, malay apple bottle, malay apple bagea, malay apple dark purple and malay apple red circle, while two potting media were top soil and sand mixture and saw dust and sand mixture. Two hormones namely Indole Acetic Acid (IAA) and Naphthalene Acetic Acid (NAA) were used at 1000 ppm.

The experiment was arranged in a complete randomized block design (RCBD) with three replications. Experimental data were analysed with ANOVA and treatment means were separated using Fishers Protected Least Significant Difference (LSD) procedure.

III. Result and Discussion

A. Time for Appearance of the First Shoot

There was a three-way significant interaction (p=0.001) among variety of malay apple, potting media and hormone for the time for appearance of the first shoot of malay apple cuttings (Table 1). Malay apple variety Bagea sprouted in 8

days when combined with IAA and the soil medium of top soil+sand and with NAA with both soil media (Table 2). However, the cuttings planted with IAA and saw dust+sand soil media produced roots in more than 9 days, although not significantly different from the test.

TABLE I
SOURCE OF VARIATION, DEGREES OF FREEDOM AND MEAN SQUARES TAKEN FROM ANOVA FOR TIME TO APPEARANCE OF THE FIRST SHOOT, NUMBER OF SHOOT AT 9 AND 12 DAYS AFTER PLANTING (DAP)

Source of variation 1/	df	Mean squares		
		Time to appearance of the first shoot	Number of shoots	
			9 DAP	12 DAP
Variety (V)	4	16.3583*** 2/	1.8057***	1.8730**
Media (M)	1	4.2667	0.3511	0.5332
Hormone (H)	1	0.0000	0.1354	0.1522
V*M	4	0.5583	0.0860	0.0486
V*H	4	1.7917	0.1902	0.2655
M*H	1	0.0667	0.0184	0.0070
V*M*H	4	10.3583**	0.6403*	1.0837*
Error	38	1.9026	0.1763	0.3321
CV%		13.75	36.40	28.30

1/ v – variety; m – soil media; and h – rooting hormone;
2/ * significant at p=0.05; ** : significant at p=0.01; *** : significant at p=0.001

TABLE II
THREE-WAY INTERACTION AMONG VARIETY, SOIL MEDIA AND HORMONE FOR TIME TO APPEARANCE OF THE FIRST SHOOT OF CUTTINGS OF MALAY APPLE

Variety	Hormone			
	IAA 1000 ppm		NAA 1000 ppm	
	Top soil+ Sand	Sawdust + Sand	Top soil+ Sand	Sawdust + Sand
Malay Apple Jati	9.7±1.16	12.7±0.58	13.0±1.73	11.3±1.53
Malay Apple Bottle	11.3±0.58	10.0±1.73	9.0±1.00	11.7±1.53
Malay Apple Bagea	8.0±0.0	10.0±3.46	8.0±0.0	8.0±0.0
Malay Apple Dark Purple	9.3±0.58	9.3±1.16	10.0±0.0	9.7±0.58
Malay Apple Red Circle	10.7±2.31	9.3±0.58	8.7±1.16	11.0±1.73

The malay variety Jati had significantly earlier sprouting in 9 days with IAA combined with top soil+sand medium, where as other combinations took more than 11 days. The variety Bottle ranged from 9 days in NAA combined with top soil + sand to 11 days with IAA and top soil + sand as well as with IAA and NAA with saw dust and sand mixtures. Although insignificant, Dark purple and Red Circle varieties too took 9 to 11 days for the appearance of first shoot.

B. Number of Shoots Produced

The number of shoots produced was also influenced by a significant three-way interaction among the variety, hormone and soil media (Table 1). The number of shoots produced at 9 DAP was nearly 1 (Table 3), while, it took 12 days for the second shoot, and the number of shoots was 2 for all the varieties (Table 4). This indicates that there was no difference in the shoot growth among the five varieties. Furthermore, shoot production increased until 18 days, and declined there after (Fig. 2).

TABLE 3
THREE-WAY INTERACTION AMONGS VARIETY, SOIL MEDIA AND HORMONE FOR NUMBER OF SHOOTS AT 9 DAP OF CUTTING OF MALAY APPLE

Variety	Hormone			
	IAA 1000 ppm		NAA 1000 ppm	
	Top soil+ Sand	Sawdust + Sand	Top soil+ Sand	Sawdust + Sand
Malay Apple Jati	1.2±0.4	0.7±0.0	0.7±0.0	0.7±0.0
	(1.00)	(0)	(0)	(0)
Malay Apple Bottle	0.7±0.0	1.6±0.8	1.4±0.6	0.7±0.0
	(0)	(2.33)	(1.67)	(0)
Malay Apple Bagea	1.9±0.3	1.4±0.6	2.0±0.3	1.9±0.3
	(3.33)	(1.67)	(3.67)	(3.33)
Malay Apple Dark Purple	1.4±0.6	1±0.5	0.7±0.0	1±0.5
	(1.67)	(0.67)	(0)	(0.67)
Malay Apple Red Circle	1.1±0.7	1.1±0.3	1.2±0.4	0.7±0.0
	(1.00)	(0.67)	(1.00)	(0)

Values are transformed to square root values; values within the parenthes are actual means.

TABLE 4
THREE-WAY INTERACTION AMONGS VARIETY, SOIL MEDIA AND HORMONE FOR NUMBER OF SHOOTS AT 12 DAP OF CUTTING OF MALAY APPLE

Variety	Hormone			
	IAA 1000 ppm		NAA 1000 ppm	
	Top soil+ Sand	Sawdust + Sand	Top soil+ Sand	Sawdust + Sand
Malay Apple Jati	2.2±0.5	1±0.5	1.2±0.4	1.8±1.1
	(4.33)	(0.67)	(1)	(3.67)
Malay Apple Bottle	2.0±0.7	2.5±0.4	2.6±0.3	1.6±0.8
	(4)	(5.67)	(6.33)	(2.33)
Malay Apple Bagea	2.5±0.3	2±1.3	2.9±0.1	2.8±0.1
	(5.67)	(4.67)	(7.67)	(7.33)
Malay Apple Dark Purple	2.2±0.3	2.2±0.1	2.3±0.2	2.1±0.2
	(4.33)	(4.33)	(5)	(4)
Malay Apple Red Circle	1.6±0.7	1.8±0.3	1.9±0.7	1.7±0.9
	(2.33)	(2.67)	(3.33)	(3)

Values are transformed to sqrt values; value within the parenthesis is the actual mean.

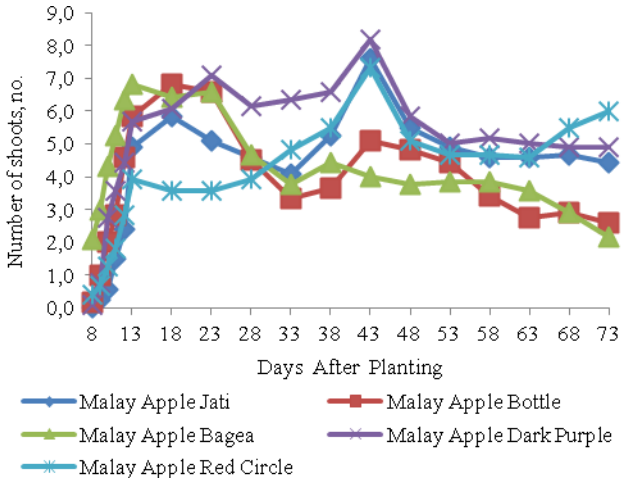

Fig. 2. Number of shoots produced by malay apple varieties

C. Root Volume

The volume of roots produced by cuttings was significantly influenced only by the interaction between potting media and hormone, but not by single factor alone (Table 5). The results showed that NAA combined with sawdust + sand mixture had the highest volume of roots and was significantly greater than other combinations of the factors, except with IAA and top soil + sand mixture (Fig. 3).

TABLE 5
SOURCE OF VARIATION, DEGREES OF FREEDOM AND MEAN SQUARES TAKEN FROM ANALYSIS OF VARIANCE (ANOVA) FOR ROOT VOLUME IN THE LAST OF EXPERIMENT

Source of variation 1/	df	Root volume
v	4	0.3884
m	1	1.3222
h	1	0.4242
v*m	4	0.0965
v*h	4	0.2644
m*h	1	2.7524*
v*m*h	4	0.6096
R	2	0.6327
Error	38	0.4367
CV		47.28

1/ v – variety; m – soil media; and h – rooting hormone;
* : significant at p=0.05; ** : significant at p=0.01; *** : significant at p=0.001

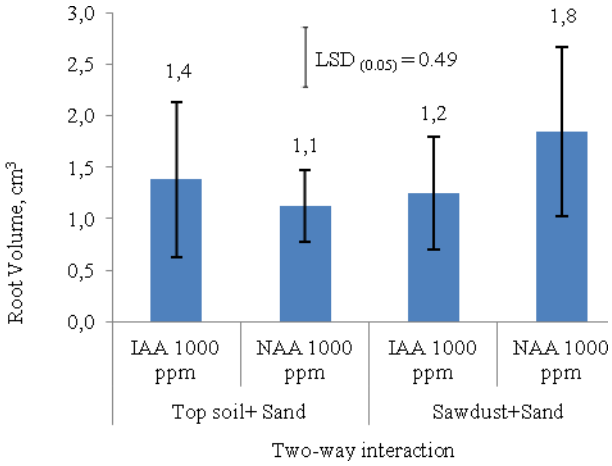

Fig. 3. Root volume of malay apple cuttings as influenced by the two-way interaction between potting media and hormone.

The propagation of malay apple is considered as less successful by both cutting and budding methods [22]. However, other species of the Myrtaceae family have been subjected to propagation studies in Australia and some European countries like Belgium and Germany with Syzygium paniculatum Gaertn, a species native to Australia by stem cuttings as the ornamental plants [7]. In the current study, the cuttings of different varieties of malay apple responded differently to treatments. The five varieties of malay apple took short period to produce cuttings: most effective to use malay apple Bagea. Typically, this variety of malay apple needs more attention when compared to other varieties, especially with rot caused by fungal attacks on the cuttings [15]. In contrast, Jati was variety showed very slow appearance the first shoot, but in the last, this variety can produce better roots compared to other varieties of malay apple. The performance of malay apple variety Red circle had the lowest number of shoots in the beginning, but gave good rooting at last.

The differences among varieties can be attributed to different mechanisms to adaptation [14], which include the rate of metabolism process during producing shoots and roots ([8], [9], [15],[21], [24]). The condition of carbohydrate status ([13, [15]) in the cuttings may also influence the root and shoot production and performance of malay apple. It has been observed that leaves that already exist on cuttings fall during root inducing period, and this could be assumed as a mechanism to allocate more energy for root initiation [15].

Although there were insignificant effects of the main factors, potting media composed of saw dust and sand media with 1:1 proportion promoted shooting and rooting. Even top soil + sand induced shoots more than seen as an interaction with hormone (NAA 1000 ppm) ([15], [.25]). This was probably due to available nutrients ([18], [22], [27]) to cuttings. In contrast, the organic matter [15] in saw dust need time to decompose before ready to be used by plants. Rooting is usually influenced by physical properties of soil ([14],[15]), and hence found saw dust has a better influence than top soil due to its pore spaces.

With all observations during the experiment, the influence of hormone on shooting of cuttings was relatively similar, although NAA 1000 ppm influenced number of shoots. This probably indicated the benefit of using rooting hormone to regulate propagation of mala apple cutting ([15] [25]).

The results of this study found an interaction among variety, soil media and rooting hormone on the time to apperance of the first shoot and number of shoot at 9 and 12 days after planting. This indicates that such factors combined to stimulate rooting and shooting of malay apple cuttings. It was seen that exogenous hormone do not rapidly influence the growing of cutting, because the activity of exogenous hormone will depend on the metabolic processes inside plant cell [15].

Interaction among the factors showed that the variety Bagea, soil media top soil+ sand and hormone, NAA 1000 ppm had the best combination to stimulate shoots at 9 and 12 days after planting. This indicates that malay apple variety Bagea to be more superior and supply of NAA 1000 and top soil+ sand media could stimulate the plant to produce shoots ([12], [15]).

The top soil was found to be the best for rooting media because the physical and chemical characteristics of this component consisting a combination of minerals, decayed plant matter and nutrients from previous planting enhance absorption of nutrient by plants. This is different with saw dust as it needs more time to release nutrients following microbial decomposition. On the other hand, compactness of top soil compared to saw dust not only give the cuttings standing ability but also reduce oxidation of the hormone and remain active longer [15].

Root volume was highest with the combination of saw dust + sand media and hormone NAA 1000 ppm. Insignificant difference in dependent variables between IAA and NAA indicates the potential of using such hormones for propagation of malay apple by cuttings. Yet the use of NAA appeared better than IAA. Since synthetic auxins are not destroyed by oxidases and could persist in the plant much longer, NAA appears better than IAA [12]. The results of this research were similar to findings of Lebran et al. (1998) [7] where both IAA and NAA were used for stem cutting of Syzygium paniculatum Gaertn., and found non-significant difference between the two hormones. However, 2000 ppm of hormones caused the highest percentage of loss of cuttings and hence the lowest rooting percentage (52%).

Selection of cuttings from suitable branches [9] such as from good fruit quality and sweetness, plant vigor, absence

of diseases [15] is important for successful propagation by cuttings [15]. In addition, the timing of collecting cuttings from parent plant [21] and storing cuttings in polyethylene bags to prevent moisture loss helps avoid failures [15].

Moreover, preparation of hormones for dipping the cuttings has been suggested as time to absorb exogenous hormone differs among types of cuttings used ([12], [15]). In the current study, cuttings were dipped in the hormone solution for 24 hours.

The difficulty of propagating malay apple by cuttings is assumed due to presence of tanniferous cells in the Myrtaceae family and calcium oxalate in the cell vacuoles [7], which could inhibit root formation in cuttings [13]. Growth of malay apple seedling has been found better under the mother trees with its shade, and therefore provision of such environment appeared better for propagation of malay apple [27]. Supply of potting media comprised of sand would enhance rooting [28] as it avoids the buildup of excessive moisture and improves aeration.

IV. Conclusions

Based on the results of this study, it is found that the hardwood cutting of Bagea variety with top soil+ sand mixture and NAA 1000 ppm had the best performance in root and shoot production and volume of roots for propagation of malay apple that would help successful establishment. As a replacement soil media, sawdust + sand mixture could also be used. As malay apple in Ternate islands faces extinction due to environmental changes, vegetative propagation using the above combination and distribution of plants among the farmers are recommended.

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