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DURIAN SEEDLING AGRIBUSINESS TO ACCELERATE THE SEED AVAILABILITY

Gede Mekse Korri Arisena*, I Gusti Alit Gunadi, Anak Agung Keswari Krisnandika, Dwi Putra Darmawan, and Nyoman Tri Lukpitasari Korri
Faculty of Agriculture, Udayana University, Bali, Indonesia

*Correspondence Email: korriarisena@unud.ac.id

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ABSTRACT

The promising economic value of durian commodity is influenced by the superior characteristics possessed by each variety, especially its shape, thorn structure, taste, and thickness of the flesh. Durian agribusiness growth and expansion demands the constant availability of superior seeds. Missteps in utilizing durian seedlings will result in massive losses in time and energy put into the cultivation process, as it only could be seen after the plants bear fruit. Thus, the final objective of the study was to construct the durian seedling agribusiness model. To build a sufficient model, we initially investigated three major themes: 1) the grafting study on the four-week-old rootstock, 2) the grafting study on the two-month-old rootstock, and 3) the grafting study on the four-month-old rootstock. The eight-month study was conducted in an Experimental Garden owned by the School of Agriculture, Udayana University. Analysis of variance (ANOVA) applied to analyze the first, second, and third study aims. Depending on the analysis of the first, second, and third aims, the final objective was addressed using descriptive-qualitative analysis. Findings revealed that grafting on four-week-old rootstock was feasible. Additionally, findings reported that entres from the durian seedling did not provide optimal grafting results. Seeds from local durian varieties (consumable durian seeds) were sufficient for rootstock material. Findings suggested the utilization of local durian for the rootstock material due to their high viability in different vegetation types and tolerance to environmental stress. Entres from productive mother tree is highly advisable for grafting.

Keywords: *durian, superior seeds, breeding business*

BACKGROUND

Presently, durian fruit considers a "family ATM" among farmers. Durian is also inherently capable of living for centuries. It is referred to as a "Family ATM" because the sale price of durian fruit is currently so high that farmers are believed to be able to rely on the durian production they plant for a living. Furthermore, because durian trees can live for hundreds of years, they can provide ongoing support to farming families. Its longevity and the increased trend on the annual productivity imply a great chance of greater revenue among the farmers. Durian trees can live for more than 80 years (Zulkarnain et al., 2019) and they can produce fruit every year from the age of 8 to 10 years. However, these opportunities should be aligned with the actions to improve its production and superior variety cultivation through good agriculture practices.

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Durian agribusiness development in Bali demands the availability of superior seeds. Based on BAPPENAS (2000), durian seeds that are physically fresh, not wrinkled, and show no signs of pest or disease attack, in addition to being physiologically ripe and genetically correct from broodstock that is healthy, fertile, and has a good and productive root system. Seedlings produced from seeds meeting these criteria are expected to maintain the quality brought by their parents. Missteps in utilizing durian seedlings will result in massive losses in time and energy put into the cultivation process, as it only could be seen after the plants bear fruit such as low productivity and poor fruit quality. Ideal seed originates from a genetically superior mother tree, possesses high productivity, and derives from a proper cultivation process. To safeguard the genetic purity in durian varieties, vegetative plant propagation, especially grafting, is favorably recommended for durian breeding. Grafting intended to unite two superior qualities from two different plants to obtain a more vigor plant (Sabatino et al., 2018) and develop sufficient tolerance to abiotic (Fullana-Pericàs et al., 2020; Bai et al., 2022) and biotic stress exposures (Grieneisen et al., 2018; Mao et al., 2022). Grafting also increases nutrient uptakes in roots (Kumar et al., 2015; Djidonou et al., 2019), enhances plant performance (Domingues et al., 2017; Evizal et al., 2018; Girardi et al., 2021), and shortens the juvenile phase that greatly affects the quantity and quality of harvested crops (Santos et al., 2016; Musa et al., 2020).

Grafting, in principle, combines two different cultivars where durian trees with a strong root system and agility to the environment can be used as rootstocks and plants with superiority in producing durian fruit can be used as scions. For the time being, durian seed perceives as merely a typical leftover after consuming the durian flesh, unconsciously causing a high waste stream of durian seed. Originally, durian is widely cultivated only for personal consumption among the farmer, which may indicate them as durian connoisseurs. This situation someway ignores the prospect of these leftover seeds as seedling material for the rootstocks in durian agribusiness.

Previous studies commonly illustrated grafting practices on 1 to 1.5 years old (52 to 78 weeks) durian rootstocks. Rohman et al. (2018) in their study conducted grafting on rootstock at three different ages: 15, 17, and 19 weeks. Further, a study by Fitriyanto et al., (2019) also performed grafting at a diverse range of ages: 24, 36, and 52 weeks. Additionally, a study by Yanti et al. (2013) conducted early grafting on 8 to 12 weeks-old rootstocks.

The novelty of this study was to examine grafting of rootstocks at the age of four weeks, based on general condition and a review of the literature on grafting of durian rootstock above the age of six months. Whereas rootstocks still store a lot of chlorophyll at the age of four weeks, we can claim that it is still very rare to find articles that perform grafting research on four-week-old rootstocks. Further, the idea of post-consumed durian seed as seedling material to grow the rootstock was pretty intriguing. Subsequently, these findings would be guided the construction of a durian seedling agribusiness model. Thus, in the recent study, we ought to explore: 1) the grafting study on the four-week-old rootstock, 2) the grafting study on the two-month-old rootstock, 3) the grafting study on the four-month-old rootstock, and 4) the construction of durian seedling agribusiness model.

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RESEARCH METHODS

This study was conducted from February to October 2022. We performed the trials in an Experimental Garden owned by the School of Agriculture, Udayana University, situated in Pedungan Village, South Denpasar, at an altitude of 10 meters above sea level. The tools used were cutters, grafting scissors, plastics, and 1.5 liter-mineral water bottles as the lids, buckets, rulers, and additional stationaries. Also, we involved several materials such as growing medium (compost, husk charcoal, and cocopeat), plastic-PEs, labels, fungicides, local durian seeds (as the rootstocks), and the variety of *Bawor*, *Musangking*, and *Kane* Durian (as the entres).

The seed for the rootstocks originated from the local durian seed. It classified or graded according to its weight as presented in each trial unit. The entres were picked from its mother tree that aged more than five years and had been producing high-quality fruits. Entres were obtained from the farmer in the area of Sudaji-Buleleng Regency. In unit I, the grafting technique conducted on one-month-old rootstocks (young seed/hypocotyl with a curved structure). Grafting techniques in unit 2 were performed on two-month-old and four-month-old rootstocks.

The first, second, and third study aims were analyzed using the analysis of variance (Anova). A BNT Test with a confidence level of 5% was subsequently conducted after Anova showed significant findings to examine the effect of the proposed intervention. The fourth aim was analyzed through the descriptive-qualitative approach, highly engaging the findings from the first, second, and third aims. Through the fourth aim, we constructed the final model of the durian seedling agribusiness to enhance farmer wellness.

RESULT AND DISCUSSION

Grafting on the Four-Weeks-Old Rootstock

Table 1. shows the findings from the field observation. The analysis of variance during the sprouting (one-month-old rootstock) is presented in Table 2.

Table 1. Timing of Bud Burst on One-Month-Old Rootstock Grafting

Trials	Repetition									Mean
	I			II			III			
	1	2	3	1	2	3	1	2	3	
Kb	17	18	-	-	-	-	-	-	-	17.5
Ks	18	-	-	-	15	-	-	-	18	16.5
Kk	-	-	-	-	-	-	-	-	-	-
Bb	-	-	-	-	-	-	-	-	-	-
Bs	-	-	-	-	-	-	-	-	-	-
Bk	-	-	-	-	-	17	-	-	-	17
Mb	-	-	-	-	-	-	-	-	-	-
Ms	-	-	-	-	-	-	-	-	15	15
Mk	-	-	16	-	-	-	13	-	-	14.5

Annotation: K= variety of *Kane*; B= variety of *Bawor*; and M= variety of *Musangking*
b (>23 – ≤28 g); s (>18.0 – 23 g); and k (>13 – 18 g)

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Table 2. Analysis of Variance during the Bud Burst on One-Month-Old Rootstock Grafting

Diverseness Provenance	DB	JK	KT	F-hit	F-tab
Group	2	0.377880	0.188940	0.3994	3.630
Experimental	8	2.536684	0.317086	0.6702	2.590
Type of entres	2	1.219266	0.609633	0.2886	3.630
The rootstock seedling size	2	0.246888	0.123444	0.2609	3.630
Interaction	4	1.070529	0.267632	0.5657	3.010
Random	16	7.569500	0.473094		
Total	26	10.484064			

KK= 63.46 %

The success rate of one-month-old-rootstock grafting documented in the recent study. It was illustrated by the fusion capability of the rootstock and scion at the rate of 11.11%. Skill in attaching the rootstocks and scions is vital to maximizing the join rate. Advanced skill had been mentioned elsewhere as a critical factor in fusing substandard maturity entres during the grafting process. The typical issue encountered was the diameter difference between the rootstock and entres. The mean success fusion rate was 16.1 days after the grafting. No interaction discovered between the trial units. Also, no significant successful join rate was reported according to the statistical analysis, variety of durian, and seedling size (Fcount<Ftable).

Grafting on the Two-Months-Old Rootstock

The fusion of the rootstocks and scion occurred on twelve trial units (37.5%) in this group (Table 3). The mean success fusion rate was 16.2 days after the grafting.

Table 3. Timing of Bud Burst on Two-Months-Old Rootstock Grafting

Trials	Repetition				Mean
	I	II	III	IV	
B-b	13	15	18	0	15.3
B-c	13	16	0	14	24.3
B-s	0	0	0	12	12.0
B-k	0	0	0	0	0
M-b	14	0	15	12	13.7
M-c	0	0	19	0	19.0
M-s	0	0	0	13	13.0
M-k	0	0	0	0	0

Annotation:

a) B= variety of *Bawor* and M=Variety of *Musangking*

b) b (>26.6 – 33.3 g); c (>19.9 – 26.6 g); s (>13.2 – 19.6 g); and k (5.5 – 13.2 g)

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Table 4. Analysis of Variance during the Bud Burst on Two-Months-Old Rootstock Grafting

Diverseness Provenance	DB	JK	KT	F-hit	F-tab
Group	3	2.200165	0.733388	0.3342	3.070
Experimental	7	32.375702	4.625100	2.1078	2.490
Type of entres	1	0.8479390	0.847939	0.3864	4.320
The rootstock seedling size	3	28.272217	9.424072	4.2947	3.070
Interaction	3	3.2555407	1.085182	0.4945	3.070
Random	21	46.080872	2.194327		
Total	31	80.656738			

KK= 77.08%

Table 4 shows insignificant statistical findings on the successful fusion rate. But, the influence of the seed weight parameter on the fusion rate was reported. The amount of food reserves (energy) available for potential plants to grow and use while the seeds are stored is related to seed weight. Seed weight is also related to the maturity of the cells in the seed. Findings suggested the range of >19.9 – 26.6 g (moderate weight) as the ideal seed weight to maximize the join or fusion rate in the grafting. In line with this finding Mejía-Jaramillo et al. (2022), also documented the ideal seed weight for the grafting process. They classified the *cv. Hass Avocado*'s seed weight (*Persea Americana Miller*) into four groups: 40-60 g, 60-80 g, 80-100 g, and >100 g. Finally, trials confirmed the significant correlation between a seed weight of >80 grams with successful germination, a higher growth rate, and better resistance.

The value of the coefficient of diversity on the one and two-month-old rootstock grafting was 63.46% and 77.08%, respectively. Besides, the statistical finding established the possible influence of myriad elements on successful graftings, such as the compatibility between the rootstock and scion, agroclimatic situation, and human skill. The compatibility of rootstock and scion greatly influences grafting success because it is related to the process of uniting plant tissues, particulary xylem and phloem, which play a role in the distribution of plant nutrients. If the network is not properly connected, the resulting tree is not healthy and may even die. Aside from genetics, the compatibility of rootstocks and scion is also influenced by human grafting skills. Aside from that, environmental factors such as irradiation, temperature and humidity, water, and nutrition all play a role in grafted plant survival.

Grafting on the Four-Months-Old Rootstock

Findings revealed that grafting on four-month-old rootstocks was relatively easier than grafting on two-month and four-weeks-old rootstocks, apparently due to their flexible and robust structure. The grafting was conducted in April 2022, and in that month, we encountered a shortage of sufficient entres caused by several factors:

1. The study period was concurrent with the post-harvesting period, for which reason, physiologically sufficient entres were not available.
2. Grafting was conducted by utilizing entres originating from durian seedling.

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Hindrances encountered also stemmed from the scarcity of the ideal new durian mother tree for the entres. The new variety of durian was rarely cultivated in Bali during the study. Grafting was conducted on four-month-old rootstock. The study period was concurrent with the post-harvesting period, resulting in stagnant phases and insufficient entres for the study prerequisite. We finally utilized the four-month-old rootstock from ready-to-plant durian seed sources, which seemed force the idea of grafting with dormant entres. These unqualified grafts contributed to a higher risk of failures, which confirmed by the "fail-to-thrive" trials unit afterward.

The successful fusion strongly depended on the compatibility between the rootstock and entres. Incompatibility may occur due to genetic factors, physiological or biochemical characteristics, lignification, plant architecture, cell fusion limitation, and conflicted metabolic scion-rootstock interaction. Different types of growth hormones such as auxin, ethylene (ET), cytokinin (CK), gibberellin (GA), abscisic acid (ABA), and jasmonic acid (JA) also regulate several vital mechanisms of plant cell fusion (Habibi et al. 2022). The seed age, seed size, seed weight, and agroclimatic situation are mentioned as the physiological or biochemical characteristics that influence plant cell fusion. The size of the avocado seed correlated with the occurrence of successful germination and grafting success rate (Lozi, Letting, and Were, 2018). In line with this finding, Akyüz, Ozturk, and Serdar (2018) mentioned the effect of the period of grafting with the fusion rate on the variety of Turkey's walnut.

Cholid et al. (2014) revealed that the older rootstock of *Jathropa curcas* associated with a higher rate of successful grafting practices. This success rate may occur due to the physical and biochemical characteristics of the fully grown rootstock. According to its physical qualities, the older rootstock has a larger diameter than the younger one, implying a more extensive root distribution. The root distribution has been widely established as a factor influenced the capability to derive water and nutrients from the cultivation medium. Further, the rootstock and scion compatibility also defined the extent of a successful union between the cambium tissues and the vessel within them. Additionally, Upadhya et al. (2014) also Damtew and Assefa (2018) established the association between the rootstock ages and successful grafting practices on *Mangifera indica*. Parallel to this finding, the utilization of the eight-year-old rootstocks of *Araucaria angustifolia* provided a higher success union rate than the thirty-five-year-old rootstocks (Gaspar et al. 2017). In line with the study, a one-month-old rootstock of *Carica papaya L.* presented a 93.3% rate of successful grafting compared to 2.3 and 6 months rootstocks (Nguyen and Yen, 2018).

Climatic factors are strongly thought of as factors impacting the success of grafting through the mechanism of entres dormancy awakening. Dormant entres have been widely utilized in grafting, mostly because they had not developed roots yet and are adaptable to water and nutrition scarcity, which displays nearly flawless material qualities for the grafting propagation technique (Landsman, 2022). Dormant entres could be adequately awakened through proper stimulation. Previous studies also applied entres in the grafting propagation of several species of crops. Aculey, Quainoo, and Mahanu (2011) also Świerczyński et al. (2020) utilized entres for *Solenostemon rotundifolius* and *Pinus mugo Turra* propagation, respectively. Several studies subsequently accentuated the effect of climate on the successful grafting rate of *Acer Platanoides* (Iliev and Tomov 2017), *Vitex payos* (Bala et al., 2017; Damtew and Assefa, 2018), and *Tamarindus indica* (Mayavel et al., 2022). Further, (Karadeniz, 2005) confirmed the influence of RH and temperature in breaking the seed dormancy,

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represented by the callus formation. The emergence of callus has been confirmed as the major sign of successful grafting on *Vitis vinifera* (Tedesco et al., 2020)**.** Temperature also reported as a vital factor in successful grafting on the entres of *Anacardium occidentale* (Chipojola et al., 2013) and *Mangifera indica L*. (Beshir, Alemayehu, and Dessalegn, 2019). Employing the indicator of growth hormone secretion, Hartmann et al. (2002) in their study acknowledged the varied effect of the hormone of BA and IBA administration on *Juglans regia L*, depending on their cultivar and genotypes. In line with this finding. Dadzie et al. (2014), also discovered that the high grafting success rate of *Cola nitida* was constituted by the rootstock genotypes.

Durian Seedling Agribusiness Model

Findings from the first and second objectives enrolled to construct a durian seedling agribusiness model. Figure 1. illustrates the entire component of the model.

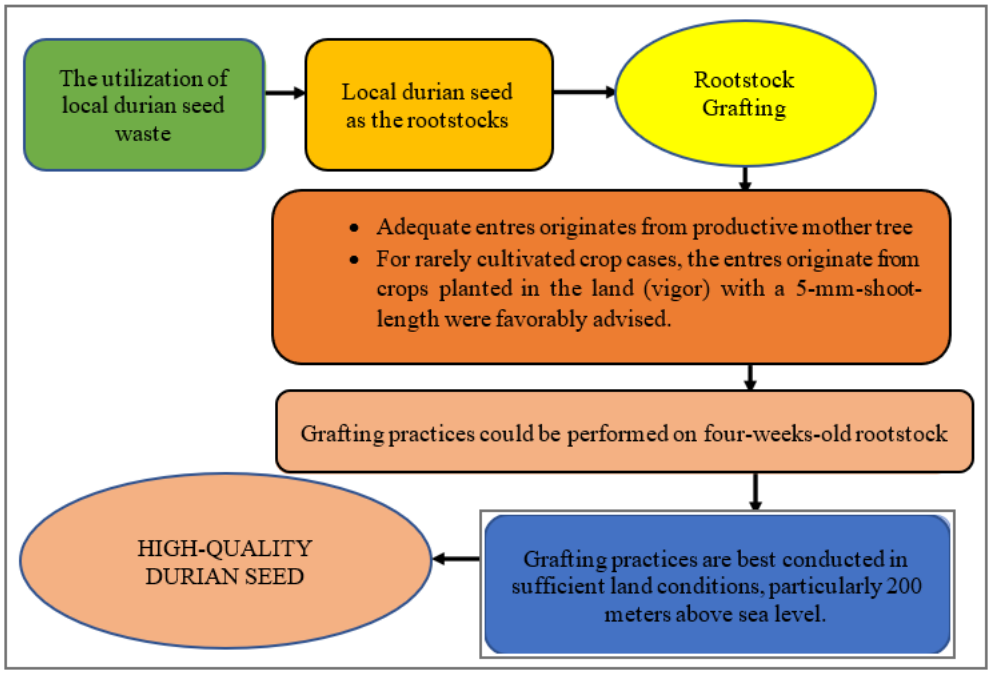

Figure 1. Durian Seedling Agribusiness Model

Durian seed perceives as merely a typical leftover after consuming the durian flesh, leading to a high waste stream of durian seed. However, this leftover had been demonstrated extensively as a proper rootstock material for durian propagation. Local durian seeds are qualified for the rootstock material due to their high viability in diverse vegetation types and tolerance to environmental stress. Findings also suggested the provenance of productive entres from the mother tree with high-quality production of fruit. For rarely cultivated crop cases, the entres originating from crops planted in the land (vigor) with a five-millimeter shoot length were favorably suggested. Grafting practices are best conducted in sufficient land conditions, particularly 200 meters above sea level. The Experimental Garden, owned by the Agricultural Faculty, Udayana University (located at Pulau Moyo Street, Denpasar), was selected as the study location to cultivate the durian grafting, which revealed later that it did not offer the best environment to grow durians.

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One of the factors influencing the success of durian cultivation is the availability of high-quality seeds. Durians can be propagated vegetatively. The vegetative propagation technique employs the use of plant vegetative organs, the results of which have the same characteristics as their superior parents (same genetic potential) and a short harvest period. Grafting is one method of vegetative propagation. Grafting is the process of combining the rootstock (stock) and the scion (entres) to create a plant with the characteristics of both the rootstock and the scion. Grafting technique on Durian plants has the advantage of being able to do it earlier, namely on rootstock seedlings that are only two months old, with a high grafting success rate of around 80%, ensuring that quality seeds are obtained in a short time and in the desired amount. Furthermore, genetic quality can be maintained and even improved, fruiting time is shortened, roots are stronger, and plant size is reduced.

CONCLUSION AND SUGGESTION

Successful graft union relied on seed age, climatic factors, seed weight, and durian varieties. The successful union rate occurred more in the two-month-old rootstocks grafting than in one-month-old rootstocks (37.5% >11.1%). The seed weight and durian varieties on two-month-aged seeds were associated with successful grafting that presented by its germination. The seed weight of *Bawor* dan *Musangking* varieties classified into the moderate category (>19.9 – 26.6 g). It constantly demonstrated the highest average of bud burst timing compared to other seed varieties.

At last, we uncovered several vital findings to support the decision-making process in durian agribusiness. Local durian seeds are eligible for the rootstock material due to their high viability in different vegetation types and tolerance to environmental stress. Findings also suggested the utilization of the mother tree with high-quality production of fruit for the productive entres. For rarely cultivated crop cases, the entres originate from crops planted in the land (vigor) with a 5-mm-shoot-length were favorably advised. Grafting practices are best conducted in sufficient land conditions, particularly 200 meters above sea level. The Experimental Garden, owned by the Agricultural Faculty, Udayana University (located at Pulau Moyo Street, Denpasar), was selected as the study location to cultivate the durian grafting, which found afterward that it did not offer the best environment to grow durians.

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