

Diversity of Sapodilla (*Achras zapota* L.) Growth from Wonogiri and Bojonegoro in Different Age of Transplantation Seed.

Muhamad Agung¹, Endang Yuniastuti^{2,3*}, Parjanto²

¹Undergraduate Student of Study Program of Agrotechnology, Faculty of Agriculture, University of Sebelas Maret (UNS) in Surakarta

²Center for Biotechnology and Biodiversity Research and Development, Institute of Research and Community Services, Universitas Sebelas Maret, Jl. Ir. Sutami 36A Kentingan Jebres Surakarta 57126, Indonesia

³Lecturer staff of Study Program of Agrotechnology, Faculty of Agriculture, University of Sebelas Maret (UNS) in Surakarta

*Corresponding author: yuniastutisibuea@staff.uns.ac.id

ABSTRACT

Most farmers determine the cutting of air layer seed in a crop through the amount of the growing roots from air layer itself. The roots can be an indicator of air layer cutting method in a crop. The roots, which are too old or too young, grow less optimal in the air layer seed after being transferred into another cultivated medium. It is necessary to have knowledge about the precise age of air layer cutting so that the vegetative propagation by using air layer can be performed accurately and efficiently. The treatments in the experiment were the age of air layer and the corps accession. The result of this research indicates that the effect of different air layer age on plant growth were shown at the age of emerging buds, 180 days old plant was considered as the age of the fastest emerging shoots. The growth of Bojonegoro air layer plants results did not differ with Wonogiri air layer plants. Based on the morphological characters of Bojonegoro and Manyaran, they have differences which were assumed to be due to genetics. The purpose of the study was to see the differences in the growth of sapodilla from Bojonegoro and sapodilla from Manyaran, Wonogiri.

Keywords: accessions; air layer; roots; sapodilla.

Cite this as: Agung, M., Yuniastuti, E., and Parjanto. (2022). Diversity of Sapodilla (*Achras zapota* L.) Growth from Wonogiri and Bojonegoro in Different Age of Transplantation Seed.. Journal of Biodiversity and Biotechnology. 2(1), 14–20. doi: <http://dx.doi.org/10.20961/jbb.v2i1.61170>

Introduction

Sapodilla is native to Mexico and Central America, but is now widely cultivated in almost all tropical countries (1,2). Sawo is a tropical fruit plants suitable to grow in Indonesia. Sapodilla plants have woody stems with a sufficiently tight branching, leafy and able to grow reaching a height of over 20 meters (3). Sapodilla can grow between altitudes of 900-2500 m above sea level. Rainfall is appropriate between 1250-2500 mm / year evenly distributed throughout the year. Sapodilla grows well on alluvial soil and sandy soil; the clay is still appropriate as long as the drainage is good. Sawo quite resistant to drought. Sawo is one tree that produces tannins of white latex (4). Sawo can be divided into two types, namely the wild or dark amber and

amber forest cultivation. Wild or dark forest sawo are close relative sawo Kecik and sawo tanjung. Based on the shape of the fruit, sapodilla cultivation divided into two types, namely sapodilla and sapodilla Apples (5). 100 g of fruit flesh (6). Sapodilla fruit contains nutrients quite high with complete compositions. Some studies suggested that sapodilla fruit is good for health, especially the heart. From an ecological temperatures, precipitation, and soil; and tolerant to high salt (salinity) soil. Sawo can also be cultivated as a rehabilitation plant for post-tsunami land (8,9,10).

Based on (11) research that conducted in Yogyakarta, the cultivation and care of sapodilla plants in that region was not done properly. Fertilization was conducted in

a maximum interval of once a year. Sapodilla plants are left to grow up without pruning treatment. The state of the sapodilla plants in Wonogiri and Bojonegoro were similar. Cultivation was not optimal. Sawo were only used as complementary plants in the yard or tegal owned by the residents. There are still unknown information about the varieties, the characteristics and the productivity; hence, attempts for more cultivation to obtain a qualified sapodilla plants can't be done just yet. The quantity and quality of the fruit is not maximized because the handling is still limited, without attention to the nutrition and the other farming activities. Therefore, it is necessary to do research which includes the identification and cultivation, so that the potential of sapodilla can be used well.

Sapodilla crop cultivation can be carried generatively through seedling and vegetatively by air layering (12). Air layer propagated plants had offspring similar to its parent and more quickly to produce fruits than propagation by seedling (13). Another advantage is the technique enables to multiply plants that is difficult to do through seeds (14). Air layer carried with the aim to grow roots and the roots are used as indicators of the air layer cutting. Most farmers determine air layer cutting through roots that grow from the air layer. Air layer seedlings will be cut after the roots have grown a lot, there's even a farmer who let the roots grow overlap to cover the media and slowly slips which is actually dead. Sapodilla air layering takes a long time to grow roots due to the sap in the Sapodilla stem. (15) states Sapodilla have a brown colored stems and produce sap. According to (16), the growth of air layer roots in Sapodilla plants takes a long time which is about 6-8 months.

Roots is an indicator of a crop air layer cutting. (17) says, characterize the air layer ready to be cut is when the number of many roots and the color of the root is brown that indicates the roots are old, while according to (18) branch air layer that have roots too much and too old as visible overlap was not good. The precisely ideal cutting was when the growth of roots is still a bit, but already visible to penetrate the media, this condition indicates that the roots are active. Based on this, this research conducted to determine the differences in air layer seedling growth at different ages. This research is expected to be able to add information about air layering especially in Sapodilla plant and the best results of air layer seedlings growth can be

used as recommendation for farmers to cut air layer in accordance with the ideal age for growth.

The novelty of this research were regarding the morphological character of sapodilla plants that grow in different areas, namely East Java (Bojonegoro) and Central Java (Manyaran, Wonogiri). Differences in locations cause different ways of propagation in this case vegetative propagation by grafting.

Materials And Methods

The research was conducted through two stages, air layering and planting, and followed by observations. Sapodilla air layering conducted in Wonogiri and Bojonegoro. Planting and observations conducted at greenhouse Faculty of Agriculture, Universitas Sebelas Maret, Surakarta. The research took place during February 2015 to January 2016. The study lasted about 1 year because the age of grafting on sapodilla plants (annual plants) reached 10-20 months until they were ready to be planted as seedlings. The material used in the research were sapodilla air layer seedling originated from Wonogiri and Bojonegoro, soil, manure, plastic, root PGR (root up), compost, and chaff. The tools used include knives, raffia rope, buckets, polybags, ruler, sprayer, and saw. The research used Completely Randomized Design (CRD) with two factors: the age of the air layer and plant accessions. The first factor was the age of air layer consisted of 120 days after air layer (M1), 150 days after air layer (M2), and 180 days after air layer (M3). The second factor was sapodilla accession plants; which include, d Manyaran (Wonogiri) accession (A1) and Bojonegoro accession (A2). From the design 6 combinations of treatment were obtained. Each treatment combination was repeated four times resulting in 24 experimental units. The data were analyzed using ANOVA on observations variables of shoots age emergence, shoot number, leaf number and leaf area. If there were significant differences, the analysis then continued with DMRT 5 % test to determine which treatment was significantly different. Observation variables of number of roots, plant height and percentage of live plants were analyzed descriptively.

Results and discussion

Number of Root

Based on table 1, the number of roots in Wonogiri accession has increased from 120 day of age (3 roots) to the age of 150 day (10 roots), but decreased at 180 days of age (8.25 roots). The number of roots in Bojonegoro accession increased from 120 Day age (6 roots), 150 Day age (16 roots), and 180 Day age (36.5 roots). In the treatment of air layer age, the number of roots 180 days of age has

the highest average the number of roots (22.38 roots), while the 120 Day age has the least number of roots (4.5 roots). Number of root at 180 Day age in Wonogiri accession (8.25 roots) which is lower than the number of root 180 Day age Wonogiri accession (10 roots). Based on the accession, the whole of Bojonegoro accession (19.5 roots) showed the number of roots more than Wonogiri accession (7.08 roots).

Table 1. The Number of roots origin Wonogiri and Bojonegoro at different age of air layer

The Air Layer Age	The Number of Roots ^e		Average
	Accession		
	Wonogiri (A1)	Bojonegoro (A2)	
120 Day (M1)	3	6	4,5
150 Day (M2)	10	16	13
180 Day (M3)	8.25	36.5	22.38
Average	7.08	19.5	

^e average number of roots of four replications

DaA : Days after Air Layer

Differences in the number of roots is caused by several factors such as the selection of air layer branches. According (19), things to consider in the selection were the age and the size of the air layer branch. There will be more roots when the diameter of the branches is larger; this is because the surface area of the roots become more widespread. The age of the branch should still young enough (brown/ light brown) because branches that are too old (dark brown/ black) is generally more difficult and slower to form roots. On selecting the air layer branch, the problem is not easy to find an air layer branch uniformly on all treatments due to its location is difficult to reach. Diversity makes the diameter age branches becomes less uniform and therefore contributes to the growth of roots. Root growth adjusts to the age and size of the branch that is used.

The second factor is the time of air layering related with the season. Optimum air layering time for root growth as reported by (20) was during the rainy season because at that time the plants do more vegetative growth. The research began in March 2015 which in that month are still experiencing dry season. The dry season causes vegetative growth is not in optimum condition and the water on the media will evaporate more quickly so that the air layer media will shortage of water despite a routine

watering. Lack of water resulted air layer media dries out so that the roots are ready/ will grow to be stunted.



Figure 1. (a) Number of root air layers smallest M1A1 (b) The Number of root air layers M3A2.

The Age Of Emerging Buds

Results of the analysis of variance at 12 weeks after planting showed that the interaction between the difference of air layer ages with the different of sapodilla accession was not significantly affect the age of emerging buds. Difference of air layer ages affect significantly the age of emerging buds; it can be seen from the significant value $0.039 < 0.05$. The difference of sapodilla accession did not significantly affect the age of emerging buds (Table 2).

Table 2. Analysis of variance (ANOVA) the age of emerging buds

Source	DF	SS	MS	F	Sig.
The Air Layer Age	2	17.81	8.540	3.896	0.039*
Accession	1	0.391	0.391	0.178	0.678 ^{ns}
The Air Layer Age *	2	1.887	0.944	0.430	0.657 ^{ns}
Error	18	39.459	2.192		
Total	24	564.000			

* 0.01 to 0.05 significant

ns> 0.05 non-significant / no significant effect

Based on Table 3, the age M1 significantly different from the age M3, M2 air layer while the age M2 did not differ significantly with the age M1 and M3. The average value followed by different letters indicated significantly different treatment. The fastest age of emerging buds was on average 180 Day (16 DAT) followed by 150 Day (19 DAT) and the oldest age of emerging buds was 120 HSC (34.5 DAT). DAT is the day after planting the air layer seedlings (after the air layer seedlings planted moved). Treatment of

180 Day (M3) has the fastest age of emerging buds because it had the highest number of roots (Table 1). The root function is for absorbing plant nutrients. According to (21), in general the formation and the growth of shoots will take place after the root formed. After the primordia formed, root can function as an absorber of the food and the growing point will be able to immediately produce a plant growth regulator cytokinin which is necessary for the induction of buds.

Table 3. The age of emerging buds in Wonogiri and Bojonegoro at different air layer age

The Air Layer Age	The age of emerging buds ^e		Average
	Accession		
	Wonogiri (A1)	Bojonegoro (A2)	
120 Day (M1)	32	37	34,5 b
150 Day (M2)	20	18	19 ab
180 Day (M3)	22	10	16 a
Average	24.6	21.6	(-)

^e the age of emerging buds average of four replications

The average value followed by different letters show significant difference according to DMRT test level of 5%.

DAT: days after transplant

The Number of Shoots

Results of analysis of variance at 12 MST showed that the interaction between different ages with different sapodilla accession did not significantly affect the number of shoots.

Difference of air layer age did not significantly affect the number of shoots. Similarly, difference of sapodilla accession also did not significantly affect the number of shoots because the significance value <0.05 (Table 4).

Table 4. Analysis of variance (ANOVA) for the number of shoots at 12 MST

Source	DF	SS	MS	F	Sig.
The Air Layer Age	2	172.750	86.375	2.475	0.112 ^{ns}
Accession	1	135.375	135.375	3.879	0.064 ^{ns}
The Air Layer Age *	2	81.250	40.625	1.164	0.335 ^{ns}
Error	18	628.250	34.903		
Total	24	2701.000			

* 0.01 to 0.05 significant

ns> 0.05 non-significant / no significant effect

The Number of Leaves

Based on Table 5, air layer age and sapodilla accession treatment did not affect significantly to the number of leaves with a significance value 0.082 on the sapodilla accession and 0.103 at the air layer age < 0.05.

The interaction between the two treatments also did not significantly affect the number of leaves. Although the provision of treatment had no significant effect, but the observations showed the development of the number of plant leaves.

Table 5. Analysis of variance (ANOVA) number of leaves at 12 MST

Source	DF	SS	MS	F	Sig.
The Air Layer Age	2	35.935	17.968	2.582	0.103 ^{ns}
Accession	1	23.586	23.586	3.389	0.082 ^{ns}
The Air Layer Age *	2	12.264	6.132	0.88	0.431 ^{ns}
Accession					
Error	18	125.281	6.960		
Total	24	1239.000			

* 0.01 to 0.05 significant

ns> 0.05 non-significant / no significant effect

The Leaf Area

Based on the results of analysis of variance, the air layer age and sapodilla accession did not significantly affect the leaf area. The interaction between the two

treatments also did not significantly affect the leaf area (Table 6). Although the provision of treatment had no significant effect, but the observations showed the development of sapodilla leaf area.

Table 6. Analysis of variance (ANOVA) the leaf area at 12 MST

Source	DF	SS	MS	F	Sig.
The Air Layer Age	2	25.959	12.980	0.307	0.739 ^{ns}
Accession	1	8.992	8.992	0.213	0.650 ^{ns}
The Air Layer Age *	2	84.774	42.387	1.004	0.386 ^{ns}
Accession					
Error	18	760.180	42.232		
Total	24	5281.217			

* 0.01 to 0.05 significant

ns> 0.05 non-significant / no significant effect

The Plant Height

According to table 7, M2A2 (6.88 cm) was the highest growth of plant, while the lowest was M1A1 (0.75 cm). Plants on the M2A2 has the highest plant height because M2A2 plants have number leaves more than the other treatments (Table 4) and only one sample of dead plant from four plant samples.

(22) explained, nutrients from the roots will be sent to the leaves for photosynthesis. The higher number of leaves made the process of photosynthesis conducted by more leaves and will increase the yield of photosynthesis. The results of photosynthesis are then used for plant growth and one of them is stem growth (height of plants).

Table 7. The high growth of plants per treatment for 12 MST observation

The Air Layer Age	The high growth of plants ^e		Average
	Accession		
	Wonogiri (A1)	Bojonegoro (A2)	
120 hsc (M1)	0.75	3.38	2.06
150 hsc (M2)	4.25	6.88	5.56
180 hsc (M3)	1.5	2.25	1.87
Average	2.16	4.16	

e :The height growth average of four replications

DAT : days after transplant

The Percentage of Life Plant

Based on Table 8, the highest percentage sapodilla life plant until the end of the observations was in the M1A2 treatment (100%), while the lowest percentages were on M3A, M3A2, and M1A1 (25%). Based on air

layer age treatment, the 150 DaA (75%) were treatment with the highest percentage; while based of accession, Bojonegoro accession (66.67%) had a higher percentage than the Wonogiri accession (41.67%).

Table 8. Percentage life plant of each treatment up to 12 MST observation

The Air Layer Age	Percentage life plant ^e		
	Accession		Average
	Wonogiri (A1)	Bojonegoro (A2)	
120 hsc (M1)	25	100	62.5
150 hsc (M2)	75	75	75
180 hsc (M3)	25	25	25
Average	41.67	66.67	

e The Percentage life plant average of four replications
DAT : days after transplant

M1A1, M3A1, and M3A2 treatments had a low percentage of life plant due to the formation of roots are less than optimal due to the low number of shoots (Table 4). The less root formation than optimal cause root becomes less robust and the consequences is if the environmental conditions around the plant root growth harmed the plants, such as pest or disease pathogens, the roots are easily damaged (23). It will then led to root damage and nutrients cannot be absorbed by the plants until the plants die. The shoots' played role in the formation of plant roots; because the shoot tips are auxin production center. According (24), auxin functions on the formation of roots, shoots developments, fruit formation, and cell development. Hormone auxin are mainly present on plant meristem tissues such as buds, flower buds, shoots, and others. Auxin formation center is at the tip of the coleoptile (shoot tip).

Conclusion

Based on the research results, it can be concluded as follows:

1. The effect of the difference air layer age on plant growth is at the age of emerging buds. Plants aged 180 DaA was the age of the fastest emerging shoots.
2. The growth of Bojonegoro air layer plants did not differ with Wonogiri air layer plants.
3. There was no interaction between air layer age with sapodilla accession on plant growth.
4. Based on the results, it can be suggested that the research should pay more attention

on the uniformity of branch air layer, and the cutting of the whole air layer in the treatment should be done at the same time. Hence, planting and observation can be done in the same time also so as to avoid variations. Further research needs to be done on air layer sapodilla using media other than soil and do a comparison effect on the growth of root air layers between soil media with the media.

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