JPPIPA 10(3) (2024)

Jurnal Penelitian Pendidikan IPA

Journal of Research in Science Education

http://jppipa.unram.ac.id/index.php/jppipa/index

Performance of Cocoa Graft Seedlings as a Result of Different Number of Lower Stem Leaves and Entry Defoliation Time

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Received: January 15, 2024
Revised: February 16, 2024
Accepted: March 25, 2024
Published: March 31, 2024

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DOI: 10.29303/jppipa.v10i3.7176

Abstract: This research aims to see the effect of the number of leaves left on the rootstock and the best defoliation time to improve the performance of cacao shoot connection seedlings. The research was conducted in the experimental garden of Politeknik Pertanian Negeri Payakumbuh from March to July 2023. Cocoa clone ICS was used as rootstock and clone TSH as scion. The experimental design was 4x4 factorial with 3 replications, the environmental design was completely randomized design. Data were analyzed statistically using F test and DNMRT further test at 5% level. From the research and data processing, it was found that there is an interaction between the treatment of different number of rootstock leaves and different defoliation times on the performance of cocoa shoot grafting seedlings based on the variables of percentage of grafted seedlings, number of shoots, number of leaves, leaf area and weight of seedling scion. It can be concluded that defoliation of the rootstock six days before splicing with rootstock having four leaves produces the best performance of cacao shoot grafting seedlings.

Keywords: Defoliation; Entries; Rootstock; Shoot Grafting

Introduction

Cocoa (*Theobrema cacao L.*) is one of the plantation commodities that plays an important role in improving the Indonesian economy. In fact, cocoa was once a prime commodity so that Indonesia was among the five cocoa exporting countries in the world (Tresliyana et al., 2015). Kementan (2022) explained that the development of Indonesia's cocoa area over the last ten years (2013-2022) has decreased by an average of -1.80% per year, which is dominated by smallholder plantations of 98.29%, the rest by large state plantations of 0.58% and large private plantations of 1.14%, with 19.64% in the form of immature plants and 22.23% damaged plants while producing plants are recorded at 58.13%. The export-import activities of cocoa commodities in 2011-2020 illustrate the imbalance where exports have decreased in volume by -0.39% per year. In contrast, the import volume increased significantly by 29.70% per year. In terms of production, Indonesian cocoa has increased by an average of 0.96% per year, while productivity has decreased by -1.04% per year. According to Kusmiah et al. (2022), the average productivity of Indonesian cocoa has only reached 439.5 kg/ha/year, whereas the potential is more than 2,000 kg/ha/year.

One of the reasons for the low productivity of cocoa plants is that the planting materials used are of low quality (Kouassi et al., 2018; N'zi et al., 2023). According to Thamrin et al (2019) The use of quality planting material is the main key to successful cultivation. Cocoa planting material can be obtained from generative or vegetative propagation (Poleuleng et al., 2020; Sodré & Gomes, 2019). Vegetative propagation of cocoa seedlings has several advantages, including no segregation so that the seedlings produced are relatively similar to their parents, can produce a large number of seedlings in a relatively short time, and can utilize local superior clones as a source of entres (Fathan et al., 2017). This

How to Cite:
Ningsih, M. S., Syafrison, S., Fardedi, F., Oktabriana, G., Rahmah, M., Jailani, H. Y., & Mukhlis, M. (2024). Performance of Cocoa Graft Seedlings as a Result of Different Number of Lower Stem Leaves and Entry Defoliation Time. *Jurnal Penelitian Pendidikan IPA*, *10*(3), 1451–1460. https://doi.org/10.29303/jppipa.v10i3.7176

propagation technique can also prevent the spread of pests from one place to another, and is easy for farmers to do.

Top grafting (Top Grafting) is one way of vegetative plant propagation (Isele, 2020). Shoot grafting technology for cocoa is the combination of two different individual clones of cocoa plants into one unit and they grow into a new plant. Usually carried out on seedlings that are 4-5 months old (Prawoto et al., 2005). This technology uses cocoa seedlings as rootstock which are connected to shoots from superior cocoa as scions (Akbar, 2017). To obtain quality grafted seedlings, rootstock and scion are needed that are compatible and can form a perfect connection plane (Heryana, 2011). The problem that farmers often face in plant propagation using the shoot grafting technique is the low percentage of grafting success. Defoliation technology on the upper stem can accelerate the growth of the buds in each leaf axil so that the buds appear fat and pithy. Defoliation of the upper stem aims to direct the translocation of photosynthesis and regulate the hormonal balance to stimulate the growth of the Connection plant (Syukri et al., 2019). Therefore, it is very important to knowing when to defoliate the upper stem is appropriate for the plant so that it can increase the success of shoot grafting in vegetative propagation.

Ramadhani (2022) said that another factor that determines the growth of the connection is the number of rootstock leaves because the leaves play a role in the process of photosynthesis of plants. However, too many leaves will increase transpiration so that plants wilt easily. The optimal number of plant leaves will accelerate growth because it will produce maximum photosynthates and suppress excessive transpiration rates.

Based on the above background, this research was conducted with the aim to see the effect of the number of leaves left on the rootstock and the best time to defoliate the scion (entres) to improve the performance of cacao shoot connection seedlings.

Method

The research was conducted in the experimental garden of Politeknik Pertanian Negeri Payakumbuh, from March to July 2023. The materials used were cocoa seedlings as rootstock from ICS clone, entres as scion from TSH clone, raffia rope, ice plastic, Urea, and Dithane M45. The tools used were pruning shears, grafting knives, digital cameras, leaf area meters, ovens, verniers, measuring cups, buckets, rulers, paddles, small sprayers, hoes and scales.

4 x 4 factorial experimental design in a completely randomized design with 3 replications. The first factor is the time of defoliation (leaf pruning), namely: D0 (during grafting), D1 (3 days before grafting), D2 (6 days before grafting) and D3 (9 days before grafting). The second factor is the number of rootstock leaflets, namely F1 (1 leaflet), F2 (2 leaflets), F3 (3 leaflets) and F4 (4 leaflets). To determine the effect of treatment data were analyzed statistically using analysis of variance (F test) and DNMRT further test at 5% real level. The variables observed were the percentage of finished grafting, number of shoots, number of leaves, leaf area, and fresh weight of the scion.

Result and Discussion

From the research and data processing that has been done, the following results are obtained:

Percentage of Finished Connections on seedlings

The percentage of finished connections of cocoa seedlings at 12 weeks after grafting is influenced by the interaction between the treatment of entres defoliation and the number of rootstock leaves, the data is presented in Table 1.

Table 1. Percentage of finished seedlings at 12 weeks after grafting

Time of defoliating entries	Percentage of seedling connections (%)							
	F1		F2		F3		F4	
D0	20.00 B	b	20.00 B	b	40.00 A	b	40.00 A	c
D1	40.00 B	a	40.00 B	a	53.33 A	a	60.00 A	b
D2	40.00 C	a	46.67 C	a	60.00 B	a	80.00 A	a
D3	20.00 B	b	20.00 B	b	20.00 B	c	46.67 A	c

Notes: Numbers in rows followed by the same uppercase letter and numbers in columns followed by the same lowercase letter, are not significantly different according to 5% DNMRT. D0 (during grafting), D1 (3 days before grafting), D2 (6 days before grafting) and D3 (9 days before grafting), namely F1 (1 strand), F2 (2 strands), F3 (3 strands) and F4 (4 strands).

Table 1 shows that defoliation of entries starting at the time of grafting until six days before grafting with all rootstock leaf count treatments showed an increase in the percentage of finished connections. Meanwhile, defoliation of the rootstock nine days before grafting with all rootstock leaf number treatments showed a decrease in the percentage of finished connections. Rootstocks that had one to four leaves showed an increase in the percentage of finished connections in all treatments when defoliating the entres.

All rootstock leaf number treatments (one to four leaves) produced a higher percentage of finished connections if the entry defoliation was carried out past three days, but closer to six days before grafting. Defoliation of the rootstock six days before grafting with four rootstock leaves produced the highest percentage of finished connections.

Defoliation of the shoots will increase the photosynthate content of the shoots. The accumulation of photosynthate will stimulate cell growth and differentiation for the formation of new tissues in the grafting area, thus increasing the percentage of finished connections (Zakariyya & Yuliasmara, 2015).

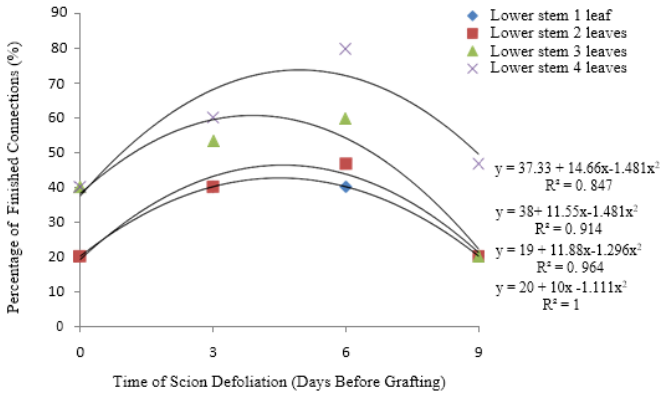

Figure 1. The trend of the percentage of finished cacao shoot connection seedlings as influenced by the treatment of entres defoliation time with the number of rootstock leaves at the age of 12 weeks after grafting

Early defoliation of the shoots up to a certain day limit will increase the percentage of finished connections in cacao shoot connection seedlings. Defoliation of the entry too early causes the scion to grow too fast. A scion that grows too fast will require a lot of photosynthate. At the same time, the connection is not yet perfect so that there is an obstacle to photosynthate translocation through the connection area. On the other hand, defoliation of entries that are carried out too late results in the scion growing too late compared to the rootstock. Compatibility of different scion growth rates with the rootstock can result in splice death.

A higher number of rootstock leaves has a positive effect on the percentage of finished cocoa shoot connection seedlings. The number of plant leaves will be related to carbohydrate reserves and photosynthate produced. More leaves will increase the photosynthate produced. The accumulated photosynthate will be used to encourage the formation of new tissues in the area of the connection, resulting in a higher percentage of finished connections. In line with the opinion of Zaubin & Suryadi (2002) which states that the process of connection requires considerable energy so that the role of rootstock leaves as photosynthate producers determines the process of connection.

When defoliating the entres with the right number of rootstock leaves, it is thought to be related to the compatibility of growth rates that encourage connection between the scion and rootstock so as to increase the percentage of finished connections (Mckenzie et al., 1988).

Number of seedling shoots

The number of shoots of cacao shoot connection seedlings at 12 weeks after grafting was influenced by the interaction between the treatment of entres defoliation and the number of rootstock leaves. The data is presented in Table 2.

Table 2. Number of shoots of cacao shoot sambung pucuk seedlings at 12 weeks after grafting

Time of defoliating entries	Number of buds (shoots)							
	F1		F2		F3		F4	
D0	1.00 B	b	10.0 B	b	1.33 AB	b	1.50 A	b
D1	1.33 A	ab	1.50 A	a	1.61 A	b	1.64 A	b
D2	1.50 B	a	1.83 B	a	2.22 A	a	2.25 A	b
D3	1.00 B	b	1.00 B	b	1.33 B	b	2.00 A	a

Notes: Numbers in rows followed by the same uppercase letter and numbers in columns followed by the same lowercase letter, are not significantly different according to 5% DNMRT. D0 (during grafting), D1 (3 days before grafting), D2 (6 days before grafting) and D3 (9 days before grafting), namely F1 (1 strand), F2 (2 strands), F3 (3 strands) and F4 (4 strands).

Table 2 shows that entry defoliation carried out from the time of grafting until six days before grafting with all rootstock leaf count treatments showed an increase in the number of buds that grew. Entry defoliation carried out nine days before grafting with one to three rootstock leaves showed a decrease in the number of buds, while rootstocks with four leaves showed almost the same number of buds between entry defoliation six days before grafting and nine days before grafting. Rootstocks with one to four leaves showed an increase in the number of shoots in all treatments when defoliating the rootstocks, except that defoliation of the rootstocks three days before grafting produced almost the same number of shoots between one to four leaves. Rootstocks with four leaves generally produced more connection buds for all treatments when defoliating the entry. (Silamat et al., 2023)

A graph of the trend in the number of shoots on cacao shoot connection seedlings due to the effect between the treatment of entres defoliation and the number of rootstock leaves can also be seen in Figure 2. Rootstocks that have one to three leaves produce more shoots if entres defoliation is carried out past three days, but closer to six days before grafting. Meanwhile, rootstocks that have four leaves produce more shoots if the defoliation of the entres is done past six days but closer to nine days before grafting.

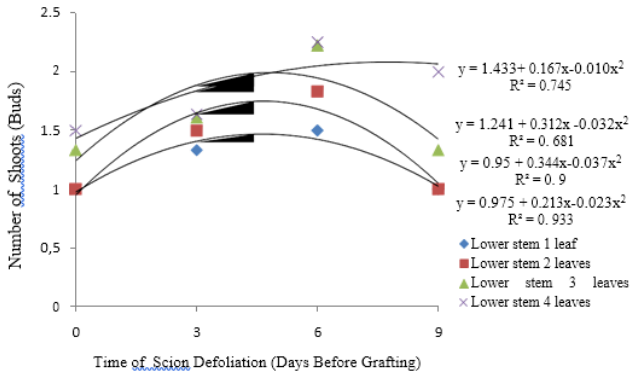

Figure 2. Trend in the number of shoots of cacao shoot connection seedlings as influenced by the treatment of entres defoliation with the number of rootstock leaves at 12 weeks after grafting

Defoliation of the entres done six days before grafting with four leaves on the rootstock produced the most shoots. This occurs because it is closely related to the balance of hormones and photosynthate content (energy source) accumulated in the defoliated entres as well as the acylate content and photosynthate potential of rootstocks that have different numbers of leaves.

Entry defoliation seems to affect the number of connection buds that grow on cacao shoot connection seedlings. Defoliation treatment will reduce the concentration of auxin in the leaf axils and increase the content of cytokinin hormones that stimulate shoot formation. The accumulation of cytokinin hormones in the entres will spur division and increase cell size as well as cell differentiation for shoot growth. In accordance with the opinion of (Taiz & Zeiger, 1998) which states that the decrease of auxin in the defoliated leaf axils will spur the formation of cytokinin hormones to stimulate shoot formation.

Defoliation of the shoots will also increase the photosynthate content of the defoliated shoots. The accumulation of photosynthate will stimulate growth resulting in an increase in the number of shoots that grow Lukman (2004) stated that defoliation treatment can increase the accumulation of photosynthate in the branches of defoliated entries. The accumulation of photosynthate will stimulate the formation of buds because buds are a strong sink.

Defoliation of the entres carried out earlier until a certain day limit can increase the number of connection buds on cocoa shoot connection seedlings. Defoliation that is done too early decreases the number of buds that grow. Late defoliation also reduces the number of shoots that grow. It seems that there is an optimal time for defoliation to produce the highest number of connection buds.

Defoliating the entry too early will cause the scion to grow too fast. Rapid growth requires a lot of assimilate. However, because the connection is not yet complete, there will be obstacles to the translocation of assimilate from the rootstock, thus interfering with the growth of the scion. The process of connection varies depending on the species and age of the plant. (Villalobos & Aquilar, 1991) found that the micro-grafting process of 3-week-old cocoa seedlings took 40 days. On the other hand, late defoliation of the scion will cause the scion to grow more slowly.

Differences in the growth rate of the scion and rootstock result in incompatibility of growth and connection. This situation results in disruption of the growth of the connection buds including the number of buds that grow. In line with the opinion of (Hartmann et al., 1997) which states that shoot growth will be disrupted or even die if there is incompatibility of the connection.

A sufficient number of leaves will produce maximum photosynthate and reduce excessive transpiration so that the plant grows well and does not wilt easily. More leaves on the rootstock seem to produce more shoots on the cocoa shoot connect seedlings. This result is in accordance with the research of Zaubin & Suryadi (2002) which found that more rootstock leaves in cashew (Anacardium occidentale) shoots will produce more shoots.

Leaves function as photosynthate producers for plant growth and development. More leaves will produce more photosynthate. The photosynthate produced will be used for the growth of the connection

buds. In accordance with that Waard et al. (1983) stated that the depletion of energy for the process of shoot growth and connection will be quickly replenished if the number of leaves that are actively photosynthesizing more. Furthermore, Sukarman et al. (2002) stated that a greater number of leaves and a higher chlorophyll content will produce more photosynthate, allowing plants to grow rapidly.

The right time of entry defoliation and the right number of rootstock leaves will produce the highest number of buds. Entry defoliation carried out at the optimal time with a sufficient number of rootstock leaves will result in compatibility and a perfect connection process between the scion and rootstock. The scion whose growth is compatible with the rootstock and the perfect connection will facilitate the translocation of photosynthates, water, hormones and enzymes so that it will encourage the growth of the number of connection buds. In accordance with the opinion of Muthohar (2007), a compatible connection between the scion and rootstock will produce a large number of connection buds.

Number of Seedling Leaves

The number of leaves of cacao shoot connection seedlings at 12 weeks after grafting is influenced by the interaction between the treatment of entres defoliation and the number of rootstock leaves, the data is presented in Table 3.

Table 3. Number of leaves of shoot connection seedlings at 12 weeks after grafting

Time of defoliating entries	Number of rootstock leaves (leaflets)							
	F1		F2		F3		F4	
D0	1.67	a	2.67	b	3.33	b	4.33	c
	C		BC		B		A	
D1	1.83	a	3.17	b	3.83	b	5.61	b
	C		B		B		A	
D2	2.67	a	5.00	a	6.78	a	7.33	a
	C		B		A		A	
D3	2.00	a	2.67	b	3.33	b	4.56	c
	C		BC		B		A	

Notes: Numbers in rows followed by the same uppercase letter and numbers in columns followed by the same lowercase letter, are not significantly different according to 5% DNMRT. D0 (at grafting), D1 (3 days before grafting), D2 (6 days before grafting) and D3 (9 days before grafting), namely F1 (1 strand), F2 (2 strands), F3 (3 strands) and F4 (4 strands).

Table 3 shows that entry defoliation carried out from the time of grafting until six days before grafting with two to four leaves on the rootstock showed an increase in the number of leaves that grew. Entry defoliation carried out nine days before grafting by leaving two to four leaves on the rootstock showed a decrease in the number of leaves. Meanwhile, rootstocks with one leaf showed almost the same number of leaves at all times of entry defoliation. Rootstocks with one to four leaves showed an increase in the number of leaves in all treatments at the time of entry defoliation.

A graph of the trend in the number of leaves on cacao shoot connection seedlings due to the effect between the treatment of entres defoliation and the number of rootstock leaves can also be seen in Figure 3.

Figure 3 shows that rootstocks with one leaf produced more leaves if defoliation was done six days before grafting. Meanwhile, rootstocks with two to four leaves produced more leaves if the defoliation was done later than 3 days but before 6 days before grafting. Defoliation of the rootstock six days before grafting with four leaves on the rootstock produced the highest number of leaves.

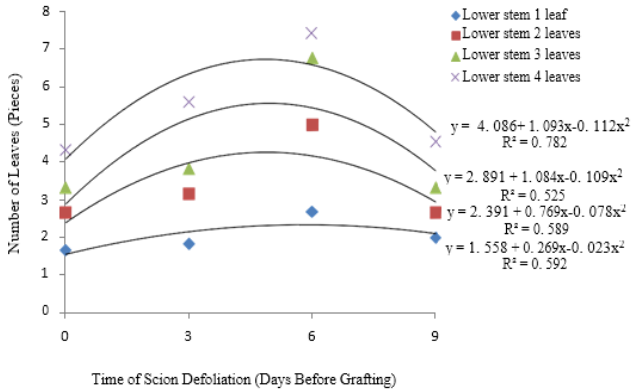

Figure 3. The trend in the number of leaves of cacao shoot grafting seedlings as influenced by the treatment of entres defoliation with the number of rootstock leaves at 12 weeks after grafting.

The highest number of leaves in this study was 7.33 leaves. However, it is still lower than the results of Rajoniati (2011) who found that the number of leaves of 11-week-old cocoa joints had reached 8.98 leaves. This phenomenon is thought to be closely related to air humidity. During the study, the daily average air humidity was generally low, below 80%. Low air humidity results in less leaf growth.

Defoliation of the centres affects the number of leaves on the cacao shoot connection seedlings. Defoliation can reduce the auxin hormone content in the seedling and increase the cytokinin hormone content. An increase in cytokinin hormone content can spur an increase in the number and size of cells and cell differentiation for the formation of plant leaf organs. In accordance with the opinion of Alvim et al (1972) which states that defoliation treatment will reduce the content of auxin hormones and stimulate the movement of cytokinins to spur shoot growth which affects the number of leaves of the connection.

Defoliation of the seedlings carried out earlier up to a certain day limit can increase the number of leaves on cocoa shoot connection seedlings. Defoliation of the seedlings that is done too early decreases the number of leaves that grow. Conversely, defoliation that is too late also reduces the number of leaves that grow. It seems that there is an optimal time to defoliate the seedlings to produce the most number of leaves.

It is sufficient to defoliate the entres six days before grafting in order to produce the most leaves of cocoa shoot connection seedlings. Almost the same fact was also found by Lukman (2004), who found that defoliation of cashew shoot grafted seedlings done three to six days before grafting produced the highest number of leaves. The number of rootstock leaves affects the number of connection leaves on cacao shoot sambunguk seedlings. Rootstocks that have more leaves produce more seedling leaves as well.

Leaves play an important role in the process of plant growth, because in the leaves the photosynthesis process occurs. A sufficient number of leaves will produce more photosynthate as energy for growth so that plants grow rapidly. More photosynthate will be used to spur the growth rate of the number of scion leaves.

The results of the statistical analysis also showed that the treatment of the time of defoliation of the entrails and the number of rootstock leaves can stimulate the growth of the number and length of the connection shoots. The number and length of shoots will be positively correlated with the number of leaves. More and longer joint buds will increase the number of leaves that grow. The optimal defoliation time and sufficient number of rootstock leaves will produce the most shoots and the longest shoots, resulting in the most leaves.

Leaf Area of Seedlings

The leaf area of cacao shoot connection seedlings at 12 weeks after grafting was determined by the interaction between the treatment of entres defoliation and the number of rootstock leaves, as well as each factor presented in Table 4.

Table 4. Leaf area of cocoa seedlings at 12 weeks after grafting

Time of defoliating entries	Leaf area (cm2)							
	F1		F2		F3		F4	
D0	72.8.4 D	c	115.29 C	c	174.10 B	c	202.32 A	c
D1	118.38 D	b	176.35 C	a	190.84 B	b	227.53 A	b
D2	144.17 D	a	179.15 C	a	212.71 B	a	266.78 A	a
D3	63.87 D	c	145.50 C	b	174.87 B	c	209.26 A	c

Notes: Numbers in rows followed by the same uppercase letter and numbers in columns followed by the same lowercase letter, are not significantly different according to 5% DNMRT. D0 (at grafting), D1 (3 days before grafting), D2 (6 days before grafting) and D3 (9 days before grafting), namely F1 (1 strand), F2 (2 strands), F3 (3 strands) and F4 (4 strands).

Table 4 shows that entres defoliation carried out from the time of grafting until six days before grafting with all treatments of the number of rootstock leaves showed an increase in grafting leaf area. Meanwhile, defoliation of the shoots carried out nine days before grafting with all rootstock leaf number treatments showed a decrease in leaf area. Rootstocks with one to four leaves showed an increase in leaf area in all treatments when defoliated.

The trend graph of the leaf area of cacao shoot grafting seedlings due to the effect of the treatment when defoliating the corm and the number of rootstock leaves can also be seen in Figure 4.

Figure 4 shows that all treatments of the number of rootstock leaves produced wider leaves if the defoliation of the entres was done later than three days, but closer to six days before grafting. Defoliation of the rootstock six days before grafting with four rootstock leaves produced the largest leaves.

Entry defoliation affects leaf area in cacao shoot grafting seedlings. Defoliation will reduce the content of auxin hormone in the rootstock and increase the activity of cytokinin hormone to stimulate the increase in size and number of cells in the leaves, thus increasing the leaf area of the connection. Lukman (2004) also stated that defoliation treatment can increase the accumulation of assimilate in the entry to stimulate division, enlargement

and differentiation of cells so that the leaves increase in size. Rootstocks that have more leaves seem to produce wider leaves on cocoa shoot connect seedlings. Leaves play an important role in the photosynthesis process of plants to produce photosynthate for the growth of the connection. More leaves will produce more photosynthate for the growth of the connection. A well-grown connection will increase the growth of its leaf area.

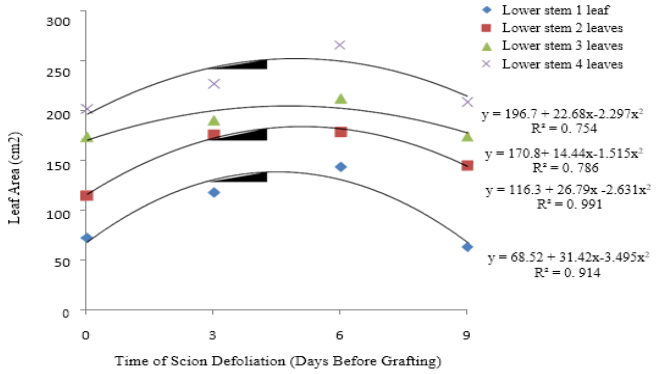

Figure 4. Trends in leaf area of cacao shoot grafting seedlings as influenced by the treatment of entres defoliation with the number of rootstock leaves at 12 weeks after grafting

Adequate supply of photosynthate from the rootstock is necessary for leaf area increase because the developing leaves are a strong sink. This is in line with the opinion of Crabbe & Barnola (1996) which explains that the rapid enlargement process of cocoa leaves is a strong sink. The flushing period that occurs in cocoa results in new cocoa leaves that have not played much role in the photosynthesis process because they do not yet contain chlorophyll.

When defoliating the seedling with the right number of rootstock leaves, it will result in compatibility and a harmonious connection process between the scion and rootstock. Compatibility and harmonious connection result in the translocation of water, nutrients, photosynthates, enzymes and hormones that are needed to run well so that plants grow better. Plants that grow well will produce wider leaves. In accordance with the opinion of Mathius et al (2007) which states that the compatibility of the growth of the scion with the matching rootstock results in the translocation of water, nutrients and photosynthates can run well so that the connection grows better. A well-grown jointed plant is closely related to the leaf area it produces.

Fresh weight of seedling scion

The fresh weight of the scion of cacao shoot connection seedlings at 12 weeks after grafting was determined by the interaction of the treatment of the time of defoliation of the entres with the number of leaves of the rootstock. The data is presented in Table 5.

Table 5. Fresh weight of the upper stem of cocoa shoot grafting seedlings at the age of 12 weeks after grafting

Time of defoliating entries	Fresh weight of scion (g)							
	F1		F2		F3		F4	
D0	3.37 B	b	5.55 A	ab	5.53 A	bc	6.02 A	cd
D1	4.72 C	a	5.70 BC	ab	6.35 B	b	7.82 A	b
D2	5.12 D	a	6.75 C	a	8.13 B	a	9.51 A	a
D3	3.69 B	b	4.96 A	b	4.90 A	c	5.66 A	d

Notes: Numbers in rows followed by the same uppercase letter and numbers in columns followed by the same lowercase letter, are not significantly different according to 5% DNMRT. D0 (at grafting), D1 (3 days before grafting), D2 (6 days before grafting) and D3 (9 days before grafting), namely F1 (1 strand), F2 (2 strands), F3 (3 strands) and F4 (4 strands).

Table 5 shows that entres defoliation carried out from the time of grafting until six days before grafting with all treatments of the number of rootstock leaves showed an increase in scion fresh weight. Meanwhile, defoliation of entries carried out nine days before grafting with all rootstock leaf number treatments showed a decrease in scion fresh weight. Rootstocks with one to four leaves showed an increase in scion fresh weight in all treatments at the time of entry defoliation.

The trend graph of the fresh weight of the scion of cacao shoot sambung pucuk seedlings due to the effect of the treatment of entres defoliation time and the number of rootstock leaves can also be seen in Figure 5.

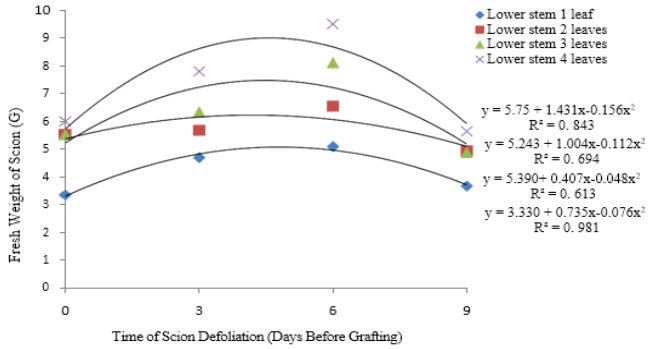

Figure 5. The trend of fresh weight of the scion of cacao shoot grafting seedlings as influenced by the treatment of entres defoliation with the number of rootstock leaves at the age of 12 weeks after grafting

Figure 5 shows that all rootstock leaf count treatments (one to four leaves) produced heavier scions if defoliation was done later than three days, but closer to six days before grafting. Defoliation of the entry six days before grafting with four rootstock leaves produced the heaviest scion fresh weight. Plant fresh weight consists of the main components of water, carbohydrates and nutrients. More water, carbohydrates and nutrients will increase the fresh weight of the scion. In line with the opinion of Salisbury & Ross (1995) which states that the high fresh weight of the plant shows that the plant grows better because the plant's metabolic activities run well.

Conclusion

From the research and analysis that has been done, it can be concluded that defoliation of the rootstock six days before splicing with rootstock having four leaves produces the best performance of cacao shoot grafting seedlings.

Acknowledgments
We would like to express our gratitude to the Politeknik Pertanian Negeri Payakumbuh for its assistance in supporting this research activity until it was published in a journal. Likewise, to all respondents involved in helping to obtain data and the local government.

Author Contributions
Conceptualization: M.S.N., Sf., Fd and G.O; methodology: M.S.N., Fd., M.R., and H.Y.J; validation: Sf., G.O and Mk; formal analysis: M.S.N., Fd.; investigation, M.R and H.Y.J.; resources: M.S.N., Sf., dan GO.; data curation, Mk and M.R.; writing—original draft preparation, M.S.N., Fd and H.Y.J.; writing—review and editing: M.S.N., Mk dan Fd; visualization, M.S.N., M.R and H.Y.J.; supervision, M.S.N and G.O; project administration: M.R and H.Y.J.

Funding
This research received no external funding

Conflicts of Interest
The authors declare no conflict of interest.

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