



The Influence of Stub Length and Texture of Pruning Wound Surface on the Wound Occlusion (Case Study on Tree Health at the Mataram University Campus)

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Abstract: Improper tree pruning, such as leaving long stubs and rough pruning wounds often leads to tree health problems in the form of poor wound occlusion. This study aimed to determine the effect of stub length and pruning wound texture on wound occlusion. Stub length was measured in cm, wound texture was scored as 0 if rough and 1 if smooth, and wound occlusion was measured as the % of wound surface area covered. The influence of stub length and wound texture was tested using regression analysis. The results showed that on short stubs (4-12 cm), smooth wounds produced good to very good occlusion, while rough wounds produced poor occlusion. As the stub length increases to 14-35 cm (medium stub), smooth wounds still produced rather to good occlusion. On long stubs (40-100 cm), maximum occlusion was only rather good and predominantly poor. In very long stubs (>100 cm), occlusion was consistently poor to very poor, regardless of wound texture. Stub length and wound texture significantly influence wound occlusion with the model $Y = 57.7283 - 0.44X_1 + 13.03X_2$. To achieve good occlusion (>65%), the remaining stub length should be <14 cm with a smooth pruning wound.

Keywords: Occlusion; Pruning wound; Stub; Tree

Introduction

As in other public areas, the development of shade trees on the Mataram University campus is of course intended to maintain environmental comfort as well as add beauty. Some of these are quite ideal, but others indicate tree health problems, such as rot and decay in the stubs left after pruning. Although rot or decay may seem trivial at first, it can have a detrimental effect on the tree's health and become structurally unstable, increasing the risk of branch breakage and tree fall. Broken branches or fallen trees can pose a significant safety hazard to surrounding property and communities. Thus, understanding the causes of tree decay or rot and implementing early detection and prevention measures is very important (Carluccio et al., 2025; Stobbe, 2002; F. Suripto et al., 2024; S. Suripto & Aksari, 2021).

Periodic and purposive tree pruning is one way to reduce the risk of tree falls and maintain their health. However, improper pruning often causes problems with tree health in the form of rot and decay in the stubs left after pruning. Post-pruning tree health assessment is typically performed by assessing the degree of pruning wound closure (occlusion). Various criteria have been developed to assess wound occlusion on stubs left after tree pruning (Clatterbuck, 2006; Ezzati et al., 2025; Fazriati et al., 2022). Causes of stub rot include physical damage due to improper pruning. Improper pruning often leaves behind branches or stubs that are too long and this is one of the causes of rot or decay. On long stubs, once the protective bark layer of the tree branch is damaged, pathogens can easily enter the inner tissues of the tree and begin the decay process. Meanwhile, the formation of callus tissue that can cover the surface of the pruning wound occurs more slowly in positions

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where the wound surface is far from the branch axil. The branch axil is where hormones that can stimulate callus tissue growth accumulate (Gauthier et al., 2015; Großmann et al., 2020; Hartman et al., 2025).

The distance between the pruning wound and the branch axil or the length of the remaining branch (stub) is strongly suspected to influence the rate of wound closure after pruning. This is related to the formation and growth of callus tissue induced by the hormones auxin and cytokinin, which typically accumulate in the axillary tissue of tree branches. Thus, wound closure by callus tissue will occur more quickly in areas near the branch axils than in wounds that are further away from the branch axils (Avifah et al., 2026; Cobb et al., 2017; Das et al., 2016; Ekawati et al., 2022).

Cutting branches that produce an uneven or rough wound surface also at the end of the stub often increases the risk of faster decay or decay. This is because an uneven wound surface has a larger surface area than a flat or smooth wound. Thus, rough wounds are at greater risk of being infected by insects, fungi or bacteria, which cause decay or decay compared to smooth wounds (Hariyati et al., 2016; Ikeuchi et al., 2016; Iriani et al., 2025).

Selecting suitable tree species or ecotypes for shade development is crucial. This is because genetic factors play a crucial role in pruning wound closure mechanisms. Tree species or ecotypes determine their ability to produce hormones related to the wound closure process. The mechanism of wound closure by callus tissue in tree trunks, especially those of hardwood species, is a natural defense response of plants to repair tissue damage (due to pruning, broken branches, or pests) through the formation of an undifferentiated cell mass. This process primarily involves the vascular cambium, which actively divides to close the wound (Fehér, 2019; Feng et al., 2024; Giannino et al., 2019; Ikeuchi et al., 2017; Romeiro et al., 2021).

External factors that often affect the wound healing process in plants are air humidity and water that wets the tree body during pruning. Pruning wounds produced during times of high humidity or wet conditions have a higher risk of being infected by bacteria, fungi and stem-rotting insects. These conditions are usually related to the weather and are factors beyond the control of tree care management, while the fineness or coarseness of the pruning wound and the length of the stub are mostly conditions that can be controlled by management factors (Ikeuchi et al., 2013; Karunarathne et al., 2024; Kleczewski et al., 2009; Nooryazdan et al., 2025).

Based on the background of the problem above, this study was conducted with the aim of determining the effect of stub length and surface quality of pruning

wound on wound occlusion in trees within the Mataram University campus.

Method

This research was conducted on the Mataram University campus. The research stages included a preliminary survey to determine the sample zones for observation and the sample trees within each zone, data collection, and data analysis. A general outline of the research workflow is shown in Figure 1.

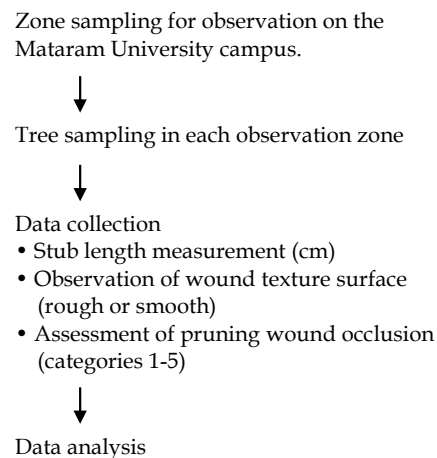


Figure 1. Work flow chart of research on the effect of stub length on pruning wound occlusion in trees on the Mataram University campus

Observation Sample

The observation area (zone) within the Mataram University campus was determined using a purposive sampling method adapted from (Self, 2020; S. Suropto, Jupri, et al., 2021). The sample zone of the observations were determined to fulfill the representation of the management area units within the Mataram University campus, in this case: FKIP, Faculty of Animal Husbandry, Faculty of Agriculture, Faculty of Mathematics and Natural Sciences, Faculty of Engineering, Faculty of Law, Faculty of Economics, Faculty of Food Technology, and Faculty of Medicine. Sample trees in each zone were also determined using a purposive sampling method, namely selecting hardwood tree species that were assumed to have the same ability in the pruning wound closure process. This tree sampling was carried out using an adapted exploration technique to find at least 12 stub cases per observation zone (Sinclair et al., 1988; F. Suropto et al., 2024).

Data Collection

The independent variables of this study were the stub length in cm (X_1) and the quality (texture) of pruning wound surface (X_2), in this case rough (given a

value of 0) and smooth (given a value of 1). The dependent variable in this study was the level of closure of pruning wounds or occlusion (Y), in this case the % area of wound closure by callus tissue. Before being used for regression analysis, the wound occlusion data in % was grouped into 5 quality categories according to adjusted criteria, namely very poor, poor, rather good, good and very good (Hecht et al., 2015; Kann et al., 2025; Neely, 1979; Ow et al., 2013) (Table 1).

Data regarding the % of the surface area of the pruning wound covered by callus tissue were classified into 5 categories of occlusion quality, using adapted criteria (Neely, 1979; Kann & Srivastava, 2025) (Table 1).

Table 1. Criteria for Classifying % Area of Closure Data of Pruning Wounds into 5 Occlusion Categories

The area of the wound surface covered by callus tissue (%)	Category
$x \leq 5\%$	Very poor
$5 < x \leq 30$	Poor
$30 < x \leq 65$	Rather good
$65 < x \leq 85$	Good
$85 \leq x$	Very good

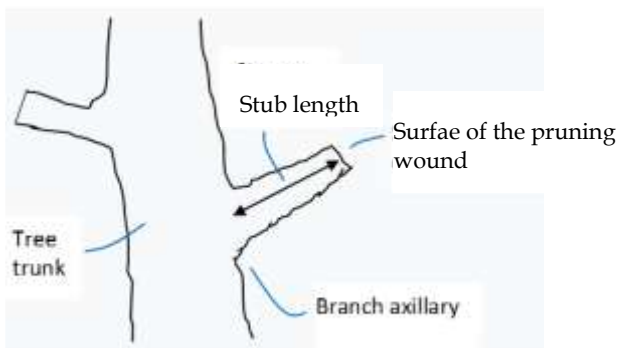


Figure 2. Sketch for measuring stub length and occlusive surface area of a pruning wound

A sketch of the tree stub observations in this study, modified from Lee et al. (2018), Purcell (Purcell, 2020), and Suropto et al. (2025), can be seen in Figure 2.

Data Analysis

Stub length data from all observed stubs were classified based on quartiles into four length classes. Each stub length class was then divided into 2 categories of quality or texture of the pruning wound surface, namely rough with a value of 0 and smooth with a value of 1. The number of stubs in each length sub-class mentioned above were calculated according to the wound occlusion category.

Stub length data in cm and wound surface texture (0 or 1) as independent variables (X_1 and X_2) and wound occlusion in % as dependent variable (Y) were processed using regression analysis.

Result and Discussion

Results

Of the 108 tree stubs observed at the Mataram University campus, their lengths ranged from 4 to 200 cm, which were grouped into 4 length classes, namely 4-12 cm, 14-40 cm, 45-100 cm and 110-200 cm. This grouping is necessary as a basis for determining the distribution of the dependent variable, in this case the occlusion of the pruning wound (Kann et al., 2025). The quality of the wound surface was observed as 0 (rough) and 1 (smooth). The occlusion value, which was % of the wound surface area covered by callus tissue, ranged from 0% (very poor) to 100% (very good). The distribution of wound occlusion values according to variations in stub length and wound surface quality of tree stubs observed in the campus of Mataram University can be seen in Table 2.

Table 2. Wound Occlusion in % (Y) and its Categories in Various Stub Length Classes (X_1) and Wound Surface Qualities, Rough = 0 and Smooth = 1 (X_2) of 108 Stubs Observed on the Mataram University Campus

Stub length class	X_1	X_2	Y	Category
	(cm)	(%)		
4-12 cm	4	1	100	Very good
	5	0	80	Good
	5	1	90	Very good
	5	1	90	Very good
	5	1	90	Very good
	5	1	100	Very good
	5	1	100	Very good
	6	1	100	Very good
	8	0	80	Good
	8	0	70	Good
	8	1	80	Good
	10	0	55	Rather good
	10	0	70	Good
	10	1	80	Good
	10	1	80	Good

Stub length class	X1 (cm)	X2	Y	
			(%)	Category
14-40 cm	10	1	80	Good
	10	1	80	Good
	10	1	75	Good
	10	1	80	Good
	10	1	80	Good
	10	1	90	Very good
	10	1	95	Very good
	10	1	90	Very good
	12	0	28	Poor
	12	1	70	Good
	12	1	80	Good
	12	1	80	Good
	14	0	50	Rather good
	14	0	50	Rather good
	14	1	55	Rather good
	15	0	40	Rather good
	15	1	55	Rather good
	15	1	55	Rather good
	15	1	60	Good
	15	1	55	Rather good
	15	1	70	Good
	15	1	70	Good
	17	1	70	Good
	17	1	65	Good
	18	1	60	Good
	18	1	50	Rather good
	20	0	20	Poor
	20	1	45	Rather good
	20	1	55	Rather good
	20	1	60	Good
25	1	30	Rather good	
28	1	55	Rather good	
30	1	40	Rather good	
35	1	30	Rather good	
35	1	55	Rather good	
40-98 cm	40	0	20	Poor
	40	1	40	Rather good
	40	1	50	Rather good
	40	1	50	Rather good
	40	1	50	Rather good
	45	1	25	Poor
	50	0	25	Poor
	50	0	20	Poor
	50	0	20	Poor
	50	1	30	Rather good
	50	1	30	Rather good
	55	1	40	Rather good
	60	0	20	Poor
	60	0	30	Rather good
	60	1	40	Rather good
	60	1	45	Rather good
	70	0	20	Poor
	70	0	20	Poor
	70	1	25	Poor
	75	0	25	Poor
	80	0	10	Poor
	80	0	10	Poor
	80	0	10	Poor
	85	0	10	Poor

Stub length class	X1	X2	Y	
	(cm)		(%)	Category
100-200 cm	90	0	5	Poor
	90	1	10	Poor
	90	1	10	Poor
	90	1	10	Poor
	95	1	10	Poor
	98	1	5	Poor
	100	0	5	Poor
	100	0	5	Poor
	100	0	5	Poor
	100	1	10	Poor
	110	0	1	Very poor
	110	0	0	Very poor
	110	1	5	Poor
	113	0	0	Very poor
	115	0	0	Very poor
	120	0	0	Very poor
	120	0	0	Very poor
	120	1	5	Poor
	130	0	5	Poor
	130	0	5	Poor
	140	0	0	Very poor
	140	0	0	Very poor
	140	1	5	Poor
	150	0	0	Very poor
	160	0	0	Very poor
	160	0	0	Very poor
	170	0	0	Very poor
	175	0	0	Very poor
180	0	0	Very poor	
180	1	5	Poor	
190	0	0	Very poor	
190	0	0	Very poor	
200	0	0	Very poor	
200	0	0	Very poor	

Some examples of stubs with their occlusion values observed in the field can be seen in Figure 3.



Figure 3. Stubs with smooth or rough wounds and their occlusion categories

The number of stubs in each length class and the quality or texture of pruning wound surface according to variations in occlusion categories can be seen in Figure 4.

On short stubs 4-12 cm long, smooth wounds produced good to very good occlusion (11 and 10 stubs), while rough wounds produced poor occlusion (1 stub). In this stub length class, wound texture was the primary determinant. As the stub length increases to 14-35 cm (medium stub), smooth wound still produced rather good to good occlusion (12 and 7 stubs), but the very good category was no longer achieved. Here, the wound texture effect is still present, but the maximum occlusion decreases. On long stubs (40-100 cm), maximum occlusion was only rather good (10 stubs) and predominantly poor (20 stubs). Here, the effect of wound texture began to weaken. In very long stubs (>100 cm), occlusion was consistently poor to very poor (10 and 18 stumps) regardless of wound surface quality. The stub's length dominates the overall outcome. Here, the wound texture was no longer helpful. Whether smooth or rough, occlusion remains poor due to the excessive length of the stub. If the stub length data (X1) is sorted in ascending order, the wound occlusion values (Y) tend to decrease (See Figure 5).

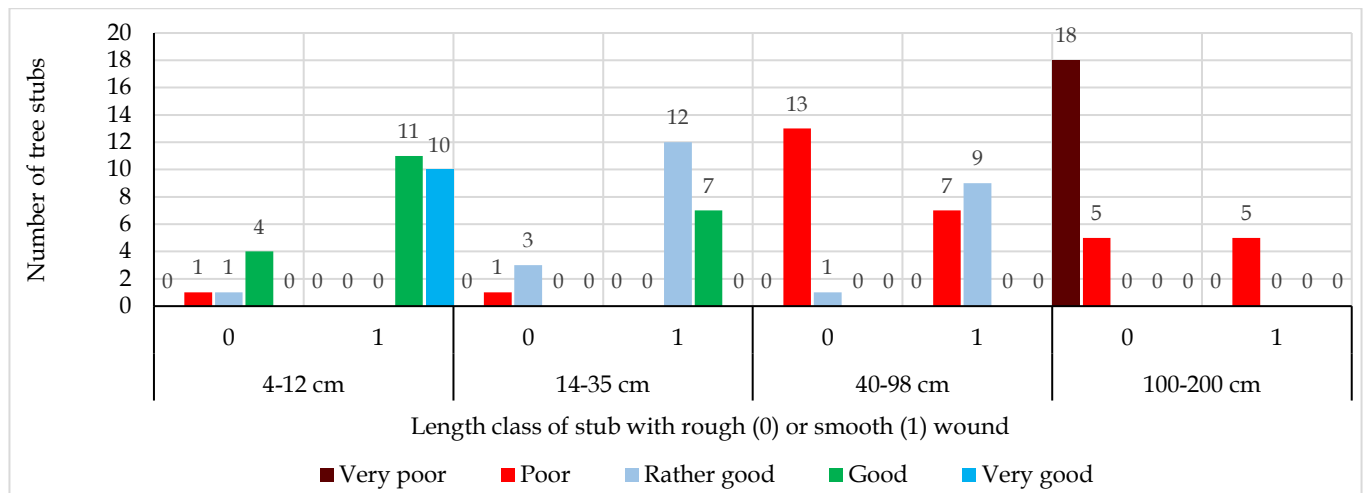


Figure 4. Number of stubs in various length classes and pruning wound surface textures according to wound occlusion categories from 108 tree stubs observed on the Mataram University campus

The results of the regression analysis showed that the length of the stub and the quality (texture) of the pruning wound surface significantly influenced the wound occlusion (Significance F = 7.52E-33), with the

resulting model being $Y = 57.7283 - 0.4357X_1 + 13.0288X_2$. The effect of the stub length and the wound texture was clear, not only is each influence the main influence, but they also modify each other.

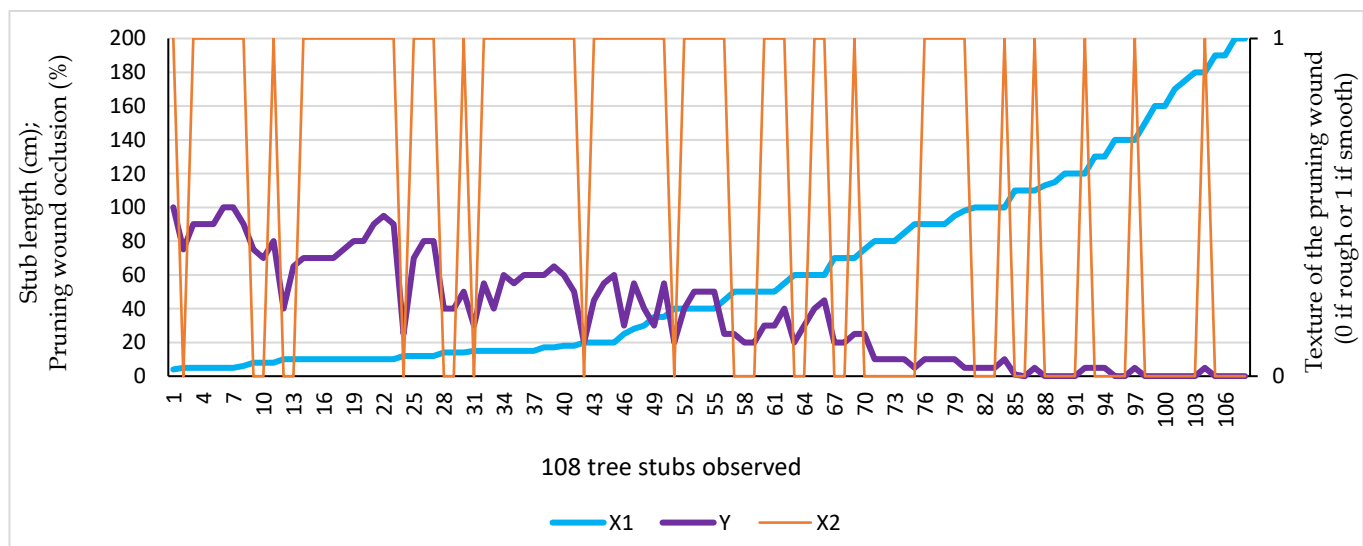


Figure 5. Visualization of the relationship between stub length and occlusion value of 108 cases of tree stubs on the Mataram University campus

Discussion

Pruning trees that leave excessively long stubs tends to result in poorer wound healing. This is related to auxin distribution. Auxin plays a crucial role in the growth of callus tissue that can cover pruning wounds. With longer stubs, auxin availability at the tip tends to decrease. Pruning branches that leave long stumps can cause disruption of nutrient transport pathways and loss of apical dominance, which inhibits the supply of auxin to the wound area (Anwar et al., 2021; Lailani et al., 2023; O’Hara, 2007; Sari et al., 2021; Walangadi et al., 2025). Longer stubs are also more susceptible to environmental stress, such as drought and extreme temperatures,

which can inhibit callus growth and interfere with wound closure (Min et al., 2016; Safitri et al., 2017; Sekar et al., 2023; Sinaulan et al., 2018; Slater, 2021b).

The research also showed that the quality or texture of the pruning wound surface affects wound closure. Smooth-surfaced pruning wounds tend to produce better wound closure than rough-surfaced wounds for several reasons, such as minimal tissue damage, reduced oxidative stress, increased enzyme activity, reduced infection, and increased cell adhesion. Smooth pruning wounds tend to produce less oxidative stress, thereby reducing the risk of inhibiting the activity of enzymes involved in callus formation and pruning wound

closure. In contrast, pruning wounds with rough surfaces tend to cause more extensive tissue damage, increase oxidative stress that inhibits the activity of enzymes associated with healing, increase the risk of infection, and inhibit cell adhesion (Iwase et al., 2021; Karunarathne et al., 2024; Lund et al., 2026; Pouzoulet et al., 2017; Slater, 2021a).

In the results of this research, tub length had a negative effect, while the quality of the pruning wound had a positive effect on wound occlusion. For every 1 cm increase in stub length, occlusion tends to decrease by 0.41%. If the stub is 0 cm ($X_1 = 0$) and the wound is rough ($X_2 = 0$), the predicted occlusion is 57.73% (rather good occlusion category), this is the basic occlusion. However, if the wound is smooth ($X_2 = 1$), then the occlusion is pushed up to 70.76% (good occlusion category). Making a smooth pruning cut can increase occlusion by 13.0288%. This is equivalent to a 39.9 cm (from 13.0288/0.4357) stub cut. This shows that a smooth wound surface is only effective in improving occlusion in short-medium stubs, while in very long stubs, the effect of stub length dominates. Consistent with the resulting model, the positive effect of smooth wound texture (X_2) can be "beaten" by the length of the stub (X_1) if it is >39.9 cm. For a target occlusion of >65% (good), a stub with a smooth wound must be < 14 cm (Ideal stub length 13 cm, tolerance limit 14 cm). A stub with a rough wound <13 cm, only up to a target occlusion of >50% (rather good). An important implication of the results is that to achieve occlusion of more than 65% (good category), pruning should be carried out in such a way that the remaining stub is as short as possible (< 14 cm) with a smooth pruning wound.

Conclusion

On short stubs (<12 cm), smooth wounds produced good to very good occlusion. As the stub length increases to 35 cm (medium stub), smooth wounds still produced rather to good occlusion. On long stubs (40-100 cm), maximum occlusion was only rather good and predominantly poor. In very long stubs (>100 cm), occlusion was consistently poor to very poor. Stub length and wound texture significantly influence wound occlusion with the model $Y = 57.7283 - 0.44X_1 + 13.03X_2$. To achieve good occlusion (>65%), the remaining stub length should be <14 cm with a smooth pruning wound.

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Author Contributions

Conceptualization, S. and L.M.A.D.; methodology, S. and S.S.; software, R.N.R.; validation, S.S.; formal analysis, S. & R.N.R.; investigation, S., L.M.A.D., R.N.R. and S.S.; resources, S.; data curation, L.M.A.D.; writing—original draft preparation, S.; writing—review and editing, L.M.A.D.; visualization, R.N.R.; supervision, S.S.; project administration, S.; funding acquisition, R.N.R. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest

The authors declare no conflict of interest.

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