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Application of Cover Type and Rootstock Height to the Success of Mango Grafting

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ABSTRACT

The availability of high-quality mango seedlings is a major challenge in improving fruit yield and quality, which can be addressed through vegetative propagation techniques, such as grafting that combines rootstocks with strong root systems and scions from superior varieties. This study aimed to determine the effects of the interaction between cover type and rootstock height on mango grafting success. This study was conducted from July to September 2022. A split-plot design was employed, with the main factor being the cover type (single and mass cover) and the sub-factor being the rootstock height (50 cm and 30 cm). The measured parameters included the time for bud emergence, percentage of bud emergence, number of leaves, and grafting success, with data analyzed using ANOVA and LSD tests at a 5% significance level. The results showed that mass cover significantly influenced grafting success, with an average time of bud emergence of 12.40 days, percentage of bud emergence of 100%, average number of leaf average of 6.90, and grafting success rate of 100%. Conversely, the rootstock height did not significantly affect these parameters. Mass cover has been proven to create an optimal microenvironment for plant growth by maintaining humidity and temperature and protecting plants against extreme environmental conditions. In contrast, grafting incompatibility was detected in certain rootstock height treatments, potentially affecting the nutrient flow and graft quality. In conclusion, mass cover had a dominant effect on grafting success, whereas rootstock height had no significant impact. No interaction was found between cover type and rootstock height in mango grafting.

Keywords: cover type, rootstock height, grafting

INTRODUCTION

One of the efforts to increase mango production involves planting superior seeds. Superior seeds, such as grafting and inoculating seeds, can be obtained by vegetative propagation (Jufran *et al.* 2021). In fruit plants, vegetative propagation is the best way to obtain high-quality seeds, particularly for grafting. (Tambing *et al.* 2008). Astutik (2008) stated that the availability of quality seeds is an obstacle to increasing the yield and quality of mango fruit, and efforts to improve the quality of mango seeds can be achieved through artificial vegetative propagation, namely, grafting. Suwitra *et al*. (2020) stated that the death of grafting seedlings without covering is caused by flush and stems stuck by splashes of soil due to rainwater, so that the plants do not grow optimally and even die until the leaves and stems look rotten and dry. Covering with plastic can create an ideal growing environment for grafting plants because the controlled lighting, temperature, and humidity of the atmosphere become more balanced, so that the metabolic process of grafting seedlings improves. Suryadi *et al*. (2018) suggested that the combination of plant cover and clear plastic helps maintain optimal moisture during grafting. Plant cover naturally absorbs and releases water slowly, whereas clear plastic prevents moisture loss through evaporation, creating an environment that supports graft joint healing.

Grafting on mangoes is a vegetative propagation technique performed as early as possible by focusing on the appropriate conditions for rootstock size, including providing a rootstock with strong and tough roots (Maulana *et al.* 2020). The condition of the rootstock size that is not appropriate has an impact on the weakness of the structure, where certain rootstocks are not strong enough to support the growth of the upper stem. The risk of fusion failure because the cambium tissue may not be mature enough to hamper the process of unification between the rootstock and upper stem can be hampered. Susceptibility to environmental stress: certain rootstocks are susceptible to changes in temperature, drought, or pest and disease attacks, which can increase the risk of graft failure. Puja *et al*. (2024) suggested that the height of the rootstock plays a role in determining how the grafted plant adapts to environmental conditions, such as the height of the graft area from the ground surface which can affect humidity and pest attacks.

Based on previous results (Pembengo *et al.* 2024), the mass cover type significantly increased the

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percentage of shoot emergence (93.5%), shoot length (1.5 cm), number of leaves (2.73 pieces), and grafting success (93%) compared with the individual cover type. The cover type in grafting functions creates an optimal microenvironment by protecting plants from extreme environmental conditions, such as direct sunlight, rain, and low temperatures. Maintaining humidity and temperature around the joint, which supports the formation of calli and vascular tissue, is important for successful grafting. Khapte *et al.* (2021) stated that there are different types of protective structures for grafted plants, such as naturally ventilated plastic houses (NVP), which provide the best microclimate conditions for the vegetative growth of grafted plants of the two types of hybrid cucumbers compared with other types of protective structures.

According to Helilusiatiningsih *et al.* (2021), treatment with a lower height of 25 cm affected the development of the number of leaves by 33.22, number of shoots by 4.35, length of the stem by 8.35 cm, percentage of longan growth by 79%, and was best at an observation age of 8 weeks. Riady and Sumeru (2017) explained that a rootstock height of 30 cm in durian grafting gave the best results in grafting success and vegetative growth compared with other rootstock heights (10 cm and 20 cm). This is due to the higher carbohydrate content in the 30 cm rootstock, which supports optimal callus production and the unification of the vascular tissue between the rootstock and scion. Better tissue unification allows for a more effective nutrient and water flow, thus improving the quality of the connection and grafting success. Based on previous research (Puja *et al.* 2024), 25 cm rootstock height had the best effect on plant height growth, although it did not have a significant effect on other parameters, such as the number of shoots and leaves. He *et al.* (2024) confirmed that rootstock size influences early growth, quality, and yield of sweet cherries in greenhouse environments.

Based on a previous study, the type of cover contributes to maintaining humidity, protecting the joint from direct sunlight, rain, and pathogen infection, and creating an optimal microenvironment for callus formation combined with a certain rootstock size that tends to assimilate the supply content for callus formation and has a compatible size to increase cambium unification. Thus, a relatively high grafting success rate was achieved. Based on this background, a study was conducted with the aim of determining the interaction between the type of cover and the height of the rootstock on the success of grafting in mango plants.

METHODS

This study was conducted in Huluduotamo Village, Suwawa District, Bone Bolango Regency, Gorontalo Province, from July to September 2022. The materials used were mango rootstock, honey mango scion, plastic cover, polybag, and organic fertilizer as a planting medium. The tools used were a cutter knife, plant scissors, and paranet.

This study used a split plot design method in which the main plot was a cover type, and the subplot was rootstock height. The main plot consisted of two levels: single cover and mass cover. The subplot consisted of two levels: rootstock heights of 50 cm and 30 cm. The four treatment combinations were triplicates to obtain 12 experimental units. There were five plant samples in each experimental unit. Thus, 60 observations were made.

The study began with creating a research layout consisting of 12 experimental units. The rootstock of the mango seedlings used was 6 months old and the height of the rootstock was measured based on the treatment. For the single-cover treatment, transparent plastic from ice plastic was used, and for the mass cover, transparent plastic from building materials commonly used in casting was used. Grafting was performed in the morning with an upper stem from a 7-year-old honey mango parent tree. Cleft grafting was used. The application of mass and single cover the day

Figure 1 Experimental layout.

after grafting activity was carried out according to the research layout (Figure 1).

The parameters in this study were time of bud emergence (days), percentage of bud emergence (%), number of leaves (strands), and success of grafting (%). Data was analyzed using Analysis of Variance (ANOVA). If there is a significantly different treatment, it is continued with the Least Significant Difference (LSD) test at the 5% level.

RESULTS AND DISCUSSION

Time of Bud Emergence

Based on the analysis of variance, the interaction treatment of the cover type and the rootstock height was not significantly different, but only the treatment of the cover type was significantly different with respect to the time of bud emergence. This is because the treatment of the cover type only affects protection and creates warmer and more humid microclimate conditions. Thus, grafted plants are protected from extreme external conditions, whereas the treatment of rootstock height tends to affect the level of availability of assimilates, which depends on the length and shortness of the rootstock height (Tambing *et al.* 2008).

The single cover treatment was significantly different from the mass cover treatment, where the single cover treatment produced a relatively faster bud emergence of 8.03 days compared with the mass cover type of 12.40 days (Table 1). This is because a single cover can create microclimate conditions that support the growth rate of shoots from the grafting of mango plants. The effects of protected structures and grafting are clearly visible in the various parameters of growth, yield, and plant quality. The structure of the cover type affects the principle of the microenvironment, especially because of changes in the intensity and diffusion of light quality that interact with various physio-biochemical plant processes, depending on the type of protective material and protective structure (Khapte *et al.* 2021). In the treatment with 50 cm rootstock height, the time of bud emergence was faster, namely 9.57 days, compared with 30 cm rootstock height, namely 10.57 days, but the difference was not significant.

Percentage of Bud Emergence

The interaction treatment of the cover type and the rootstock height was not significantly different, but only the cover type treatment was significantly different in terms of the percentage of bud emergence. As shown in Table 2, the mass of the cover type treatment resulted in a 100% higher percentage of buds emerging compared with the single cover type treatment (57%). This is because the mass of the cover type treatment can protect against extreme microclimate conditions that can trigger stress in the early development after the grafting technique of mango plants. Koepke and Dhingra (2013) stated that, in general, tolerance to biotic and abiotic stresses at the beginning of grafting plants where the rootstock is controlled through physiological, biochemical, and molecular process mechanisms in the upper stem and affects the yield and quality of the plant.

The treatment with rootstock heights of 30 and 50 cm did not differ significantly. This is thought to be due to the incompatibility or inappropriate connections in the grafting of mango plants. Martínez-Ballesta *et al.* (2010) revealed that incompatibility of grafting techniques can cause a decrease and excess growth

Table 1 Average time of bud emergence (day) based on cover type and rootstock height for the success of grafting mango plants

Treatment		Average time of bud emergence (day)
Cover type	Single	8.03 a
	Mass	12.40 b
LSD 5%		1.29
Rootstock height (cm)	50	9.57
	30	10.57
LSD 5%		-

Remarks: Numbers followed by the same letter in the same column are not significantly different from the 5% Least Significant Difference test.

Table 2 Average percentage of bud emergence (%) based on cover type and rootstock height on the success of grafting mango plants

Treatment		Average percentage of bud emergence (%)
Cover type	Single	57 a
	Mass	100 b
LSD 5%		14.32
Rootstock height (cm)	50	73
	30	83
LSD 5%		-

Remarks: Numbers followed by the same letter in the same column are not significantly different from the 5% Least Significant Difference test.

of the upper stem, which triggers a decrease in the absorption of water and nutrient flow and causes the plant to wilt. Incompatibility of grafting techniques usually occurs at an early stage, when the initial formation of vascular tissue occurs until the fruiting stage, when the plant has high water and nutrient requirements. Gainza *et al.* (2015) specified that the connection between the conductive tissue of the upper and lower stems is one of several factors in the success of the grafting technique where biochemical reactions and cell formation occur at the beginning as an effort to form plant tissue.

Number of Leaves

The interaction treatment of the cover type and the rootstock height was not significantly different, but only the treatment of the cover type was significantly different in terms of the number of leaves. This is because there is a mismatch in the relationship between the two treatments, where the treatment of the cover type plays a role in protecting the grafted plants from climatic conditions in the form of exposure to solar radiation that triggers temperature fluctuations and protection from rainfall. The rootstock height treatment contributed to the initial reserves of the rootstock assimilate content. Riady and Sumeru (2017) stated that excess carbohydrates in the rootstock and scion encourage the production of abundant calli which allows restoration of vascular tissue through induction of plant hormones.

The mass of the cover type treatment contributed to a higher number of leaves of 6.90 compared with the single cover type of 2.20 (Table 3). This is because the mass of the cover type has a wider growing space than the single cover type, which makes the development of the number of leaves higher due to the humidity and temperature conditions that are suitable for the vegetative development of the plant. The use of certain shades triggers an optimum temperature between 26 and 29°C and a relative humidity level above 80%, which is beneficial for the healing process of the graft union and for minimizing water loss. The use of the appropriate quality of the scion that matches the rootstock stock, especially with the same diameter size (Solomon *et al.* 2021).

Success of Grafting

It was shown that the interaction treatment of the cover type and the rootstock height was not significantly different, but only the cover type treatment was significantly different in the parameters of the success of grafting. The mass of cover type treatment contributed to a higher success rate of 100% compared with the single cover type of 57% (Table 4). This is because maintenance and grafting techniques require in-depth attention to achieve a high level of grafting technique success. Rahmatika and Setyawan (2018) mentioned that what needs to be considered in the success of grafting techniques is the type of rootstock, mastery of propagation techniques, maintenance of the rootstock and scion as well as post-grafting maintenance. Grafting techniques through structural and biological mechanisms of grafting between the scion and rootstock are observed in three basic phases: merging of the scion and rootstock, making callus around the joint, and building continuity at the joint through redifferentiation of vessels. Successful grafting can be achieved through wound healing and the formation of conductive vessels. Therefore, the formation of vascular connections is the last and most critical stage in wound healing because after healing,

Table 3 Average number of leaves based on cover type and rootstock height for the success of grafting mango plants

Treatment		Average number of leaves
Cover type	Single	2.20 a
	Mass	6.90 b
LSD 5%		0.18
Rootstock height (cm)	50	8.80
	30	9.40
LSD 5%		-

Remarks: Numbers followed by the same letter in the same column are not significantly different from the 5% Least Significant Difference test.

Table 4 Average success of grafting (%) based on the cover type and the rootstock height on the success of grafting mango plants

Treatment		Average success of grafting (%)
Cover type	Single	57 a
	Mass	100 b
LSD 5%		14.32
Rootstock height (cm)	50	73
	30	83
LSD 5%		-

Remarks: Numbers followed by the same letter in the same column are not significantly different from the 5% Least Significant Difference test

the transport of water and dissolved substances begins from the rootstock to the scion (Noor *et al.* 2019).

CONCLUSION

The interaction between the treatment of the cover type and the rootstock height did not affect the success of grafting mango plants, but only the mass of cover type affected the time of bud emergence by 12.40 days, the percentage of bud emergence by 100%, the number of leaves by 6.90, and the success of grafting by 100%.

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