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The Growth of Shoot Grafting Seedlings on The Differences of Mango Plant (Mangifera indica) Scion Varieties

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ABSTRACT: Mango plants (*Mangifera indica*) are plants that are highly favored by Indonesian society for consumption. Mango plants are often propagated using seeds, which takes a considerable amount of time, and the results obtained are not the same as the parent plant. This research aims to determine the effect of different Scion varieties on the growth of mango seedlings (Mangifera indica) through grafting. The research design used is a Split-Plot Design (SPD) with 2 factors, where the main factor is the shading intensity, and the sub-plot is the scion varieties. The scion varieties used are Manalagi, Gedong Gincu, and Okyong. The research results showed that the highest percentage of successful seedling growth is observed in the Manalagi scion variety, with a rate of 91.7%. Based on the average plant height, the tallest plants are found in the Gedong Gincu scion variety. The highest number of leaves is observed in the Manalagi scion variety, while the longest shoot and highest stem diameter are found in the Okyong scion variety. The analysis used the RHS Color Chart on the Manalagi scion variety, it showed that the leaf color meets the recommended standards. In the Gedong Gincu scion variety, the recommended standards are met for leaf width, leaf color, and stem color. For the Okyong scion variety, the recommended standards are met for leaf width and leaf color.

Keywords: Grafting; Mangoes; Scion Varieties.

INTRODUCTION

The mango plant (Mangifera indica) is a plant originating from India and has spread to Southeast Asia, especially in Indonesia. The spread of the mango plant in the 4th century to various countries through Indian traders is used as a means of spreading it (Pracaya, 2011). Indonesia is a country that has an abundant diversity of horticultural commodities, one of which is fruit. Mango is a horticultural commodity that has a high potential for production and consumption in Indonesia. According to BPS data (2020), in 2020 mango production will reach 2.9 million tons/year, while consumption of mangoes in the household sector will reach 154.98 thousand tons(Kim et al., 2023).

Mango fruit is a fruit that contains fiber and has a role in helping the digestive process, lowering cholesterol levels and contains nutrients including vitamins A and vitamin C as well as minerals that are beneficial to humans (Puspitasari et al., 2019). In addition to the fruit, mango skin can also have various benefits including getting rid of acne, improving blood circulation, losing weight, overcoming excessive bleeding, and also as an anthelmintic for children.

Mango plant propagation can be done in 2 ways, namely generatively by using propagation through seeds, and second through stock and scion, cuttings, shoot grafting, and shield budding. The rise of vegetative propagation is due to the use of generative propagation using seeds to obtain mangoes that have the same characteristics as their parent plant which are difficult to obtain, so vegetative propagation is widely used to reproduce mango plants (Bahri et al., 2018).

Vegetative propagation used is by using shoot grafting. Shoot grafting is a technique of joining the scion with the rootstock (seeds, rootstock, or cuttings) so that they become new plants (Dewi et al., 2018). According to Bahri et al. (2018), shoot grafting can bear fruit after 5-6 years after the shoot grafting process, and the fruit produced by shoot grafting propagation has the same characteristics as the parent plant (Lv et al., 2022).

Propagation of shoot grafting using scion varieties (*entres*) which are used as the scion(Shivran et al., 2023a). This experiment used different varieties of scion because the different varieties used can affect the quality of the fruit produced. After all, each variety has different advantages. Differences in varieties according to Maulana et al. (2020) Each mango plant has a different ability of the emergence and the speed at which the buds break will vary for each variety. Differences in scion varieties are used to produce superior fruit and are widely consumed by the wider community (Setiyono, 2017).

Vegetative propagation is mostly done to produce better quality plant seeds compared to generative propagation. Vegetative propagation can produce fruit in a shorter period and the fruit produced is the same as the parent plant. So, this is the objective of the research where the best seedling growth is produced by shoot grafting on differences in varieties of scion of mango plants.

METHOD

This research was conducted from February to July 2022 at the Experimental Garden of Campus F7, Gunadarma University, Ciracas, East Jakarta, with an altitude of 57 meters above sea level. The object of the research was the growth of shoots in mango nurseries with different scion varieties(Shivran et al., 2023b). The research material used was the Harum Manis mango which was used as the rootstock of the mango plant, while for the scion, the Manalagi mango variety, the Gedong Gincu mango variety, and the Okyong mango variety were used. The tools used include polybags, grafting knives, cutting scissors, plastic covers, plastic for connecting threads, a thermo hygrometer, and a lux meter(Babaj et al., 2014).

This research was conducted using a Split Plot Design with a randomized pattern using a Completely Randomized Block Design (RKLT). There were 2 factors with the main plot having 4 levels, namely no shade, 50% shade, 75% shade, and 90% shade. As for the subplots, there are 3

levels of the Manalagi mango variety, the Gedong Gincu mango variety, and the Okyong mango variety. Thus, there were 12 treatment combinations with 3 replications, so there were 36 experimental units. Observational data that has been carried out were analyzed by using analysis of variance (ANOVA). If there is a significant effect, then proceed with the DMRT test (Duncan Multiple Range Test) with a level of $\alpha = 5\%$ using SPSS software.

The implementation procedure begins with the preparation of the planting medium, the planting medium used is soil and also rice husk due to the mixture of soil and husk, therefore, the structure and porosity of the soil make it easier for water porosity. Preparation of grafting material begins with the provision of rootstock taken from the Ciganjur nursery ± 5 months after transplanting, where the rootstock is planted from the Harum Manis mango seeds. The scion varieties were taken from the Manalagi, Gedong Gincu, and Okyong mango varieties.

Shoot grafting is carried out after the preparation of the grafting material has been completed. Shoot grafting is done by slashing the rootstock along ± 2-3 cm, then the scion is slashed to form the letter V. After that, the rootstock is joined to the scion, and after joining it is then wrapped using plastic until all parts have been slashed are tightly closed so that water cannot enter the joint. After wrapping it, then covered using a small piece of plastic to maintain the joint, and also the water evaporation that occurs will not be too high. Then labeling to make it easier to know the treatment in the study. The maintenance that should be carried out is watering, weeding, fertilizing, pruning, opening the cover, and winding the joints. The variables observed were the percentage of seedlings growing (%), plant height (cm), number of leaves (strands), shoot length (cm), leaf length and leaf width (cm), leaf color, and stem color.

RESULT AND DISCUSSION

Percentage of Growing Seeds

The percentage of seedlings growing on the success of a study can be calculated by:

$$\text{Success} = \frac{\text{Number of growing joints}}{\text{Number of seeds graft}} \times 100\%$$

So the results can be obtained which state that from all the plants that have been carried out the results of the percentage of seeds that grow, the percentage of seeds that are growing is obtained to reach 88.9% as can be seen in Figure 1.

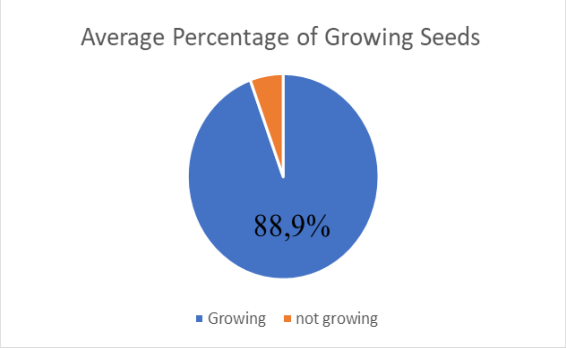

Fig 1. Average Percentage of Growing Seeds

The grafting of shoots can be said to be successful when the linkages are united and shoots and/or

shoots appear on the scion. For the percentage of seedlings growing on different scion varieties, it can be shown that the Manalagi mango scion variety has the highest yield compared to other varieties, as shown in Figure 2.

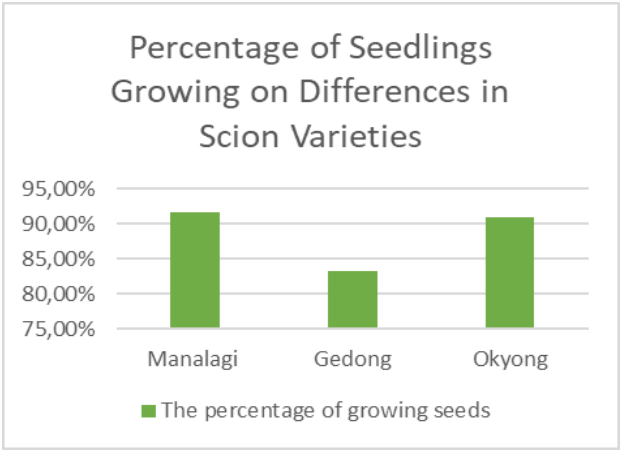

Fig 2. Percentage of Seedling Growing on Differences in Scion Varieties

Figure 2. shows that shoot grafting of the scion variety of Manalagi has the highest percentage of growing seedlings, namely 91.7%(Yadav et al., 2019). The joining process always begins with the process of wound healing in the two wounded stem tissues that have been joined. This can be in line with research conducted by Maulana et al. (2020) which states that the percentage of growing seedlings can be influenced by differences in the genetic structure of each plant. This makes the cause of the diversity of a plant, each variety has special characteristics that influence one another.

Taher (2018) states that the success rate of the grafting technique is better when it is compared to the shield budding technique because mango plants have fairly thin bark and a lot of sap. Joined plants are said to be successful if the joints are firm in the joining area and buds have emerged on the scion (Tirtawinata, 2003). According to Karsinah et al. (2017), the break of bud and the percentage of growing seeds were not affected by rootstock varieties but by scion varieties.

The Growth of Plant Height to Differences in Scoin Varieties

Table 1. DMRT further test results for plant height per week Scion varieties Week

Scion varieties	Week									
	1	2	3	4	5	6	7	8	9	10
Manalagi	10.67a	11.22a	11.83a	13.15ab	14.27	15.18	15.03ab	15.14ab	16.20a	16.18b
Gedong Gincu	11.04a	11.57a	12.27a	13.97b	15.50	16.58	16.74b	16.68a	17.78b	17.90a
Okyong	10.08b	10.58b	11.31b	12.64a	14.16	14.64	14.83a	13.86b	16.08ab	16.27a

Numbers followed by different letters in a row or column indicate a significant difference based on the DMRT (Duncan Multiple Range Test) at $\alpha = 5\%$

Table 1 shows that there were significant differences at weeks 1, 2, 3, 4, 7, 8, 9, and 10 in the treatment of differences in scion varieties to plant height. The best plant height was shown in the Gedong Gincu variety. The difference in plant height in the scion varieties could be due to the faster healing process of the cells in the plant tissue. This research is also in line with Tjitrosoepomo (2003) who stated that some plant varieties tend to adapt in extreme environments.

According to research conducted by Maulana et al. (2020), it showed that the ability of plants to survive in an environment is also influenced by the nature and genetics of these plants, then mango plants have high adaptability to soil conditions, either it is unfavorable soil conditions or high temperatures. This is because mango plants are tolerant to drought (Pracaya, 2011).

According to research conducted by Fuller (2005) in Dastama et al. (2022), it explained that the compatibility between the rootstock and scion is the main requirement that must be met to get sufficiently good-growth seeds. Entres or scions that are used poorly will greatly affect the compatibility between scion and rootstock. Based on the exposure described by Dastama et al. (2022) in their treatment of shoot grafting on Longan plants explained that cytokinin compounds found in plants will stimulate cell division and this will result in an increase in the process of protein and auxin synthesis which can trigger cell elongation.

The Growth in The Number of Leave to The Differences in Scion Varieties

Table 2. DMRT further test results for the number of leaves per week

Scion varieties	Week									
	1	2	3	4	5	6	7	8	9	10
Manalagi	0	3ab	4	6	6	8	9	8	10	11
Gedong Gincu	0	4b	5	5	6	7	9	9	9	11
Okyong	0	0a	1	6	6	7	9	9	11	12

Numbers followed by different letters in a row or column indicate a significant difference based on the DMRT (Duncan Multiple Range Test) at $\alpha = 5\%$

Table 2. shows that there is no significant difference in different varieties of the scion to the number of leaves. In the initial phase of shoot grafting growth, the leaves have not yet emerged because, in the 1st week, the plant is adapting due to wounds on the plant parts and is also in the stage of bud emergence. And in 2nd there was a significant difference in gedong gincu variety and okyong variety.

According to research conducted by Tirtawinata (2003), the process of joining plants begins with a response from cells or tissues. Research conducted by Helilusiatiningsih et al. (2021) that there was no significant effect on the treatment of plant varieties on Longan shoot grafting at all ages, whereas, in this study, things that did not differ significantly occurred in certain weeks due to the differences in the genetic characteristics of each variety and unsupported environmental conditions.

The effect resulting from the intensity of incoming light with sufficient intensity can extend the growth period of plants. The growth and production of mango seeds are also determined by the temperature and incoming light so there are differences in the growth of each existing variety. Each plant variety has a different response to environmental factors (Tjitrosoepomo, 2003).

The Growth in Leaf Leght on Differences in Scion Varieties.

Table 3. DMRT further test results for shoot length per week

Scion Varieties	Week					
	5	6	7	8	9	10
Manalagi	3.1	3.4	3.6	3.49	4.43	4.88
Gedong Gincu	3.1	3.5	3.9	3.91	4.83	5.46
Okyong	3.8	4	4	4.43	5.23	6.00

Numbers followed by different letters in a row or column indicate a significant difference based on the DMRT (Duncan Multiple Range Test) at $\alpha = 5\%$

Table 3. shows that there is no significant difference in scion varieties differences in shoot length. The highest shoot length was found in the Okyong scion variety. According to the research conducted by Waard and Zaubin (1983), the process of shoot growth and the grafting joints will be replenished more quickly if more leaves can photosynthesize. According to the opinion expressed by Pina et al. (2005), the incompatibility of rootstock and scion could be detected after several weeks of the grafting process through the joints of the vascular bundles which could be said to be quite bad and phloem degeneration at the joints, which could disrupt the flow of

incoming water which could then cause the joints to break down. Lakitan (2001) explained that the auxin and cytokinins hormones are capable of influencing cell division and cell elongation, ini which the function of cytokinins is to stimulate cell division by increasing the rate of existing protein synthesis, while the auxin itself functions as a trigger for elongation of cells which can cause elongation of stems/shoots.

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The Growth of Scion Diameter to Scion Variety Differences.

Table 4. DMRT further test results for scion diameter per week

Scion Varieties	Week								
	2	3	4	5	6	7	8	9	10
Manalagi	5.96	6.08	6.2	6.22	6.50	6.6	6.68	6.71	6.78
Gedong Gincu	6.29	6.5	6.67	6.70	6.65	6.7	6.73	6.79	6.82
Okyong	6.46	6.5	6.74	6.84	6.85	6.91	6.97	7.15	7.20

Numbers followed by different letters in a row or column indicate a significant difference based on the DMRT (Duncan Multiple Range Test) at $\alpha = 5\%$

Table 4. shows that there is no significant difference in the difference of scion variety to the scion diameter. According to research that was conducted by Ariani et al. (2017) it showed that factors that can affect growth from the diameter of the stem of this plant due to a lack of water and nutrients which should be able to be distributed directly to all parts of the plant and then must be hampered due to wound on the plant parts and the need for time to adapt with the wound plant parts. This is in line with the opinion put forward by Salisbury and Ross (1992) that plants with high enough water conditions will have better cell growth results, conversely if the water conditions are lacking this will result in inhibited cell growth and this can result in smaller stem diameters, both scion diameter, middle stem diameter (joints) and rootstock diameter.

Average Growth of Plant Height, Number of leaves, Shoot Legth and Scion Diameter on Differences in Scion Varieties

Table 5. The results of the DMRT further test the average growth in plant height, number of leaves, shoot length, and scion diameter

Scion varieties	Plant Height	Number of Leaves	Shoot Length	Scion Diameter
Manalagi	12.77	6.63	3.85	6.33
Gedong Gincu	14.23	6.58	4.13	6.52
Okyong	12.88	6.08	4.73	7.07

Numbers followed by different letters in a row or column indicate a significant difference based on the DMRT (Duncan Multiple Range Test) at $\alpha = 5\%$

Table 5. shows that there was no significant difference in the differences in scion varieties concerning the average growth in plant height, number of leaves, shoot length, and scion diameter. The highest plant height variable was found in the Gedong Gincu scion variety. The highest number of leaves variable was in the scion variety of Manalagi, while the highest shoot length and scion diameter were found in the Okyong scion variable. According to Simatupang et al. (2004), the ability of a variety to adapt to the environment and plant management is less than optimal which causes the growth of shoot grafting seedlings to be suboptimal.

According to Maulana *et al.* (2020), each variety of mango plant has a different ability to emerge the bud or the speed at which the buds break apart, this is because of the ability of the plants to

form grafting joint varieties. The use of scions/entres which has advantages in superior fruit quality makes many varieties used as scions (entres) in this shoot grafting activity used for commercial activities. This is an easier way to propagate to fulfill the market (Setiyono & Munir, 2017).

Qualitative Data (Leaf Legth, Leaf Width, Leaf Color and Stem Color) on Several Scion Varieties

Table 6. The result of qualitative data analysis

Observation Variable	Recommended Standard*)	Scion Varieties		
		Manalagi	Gedong Gincu	Okyong
Leaf Length	25 -28 cm	17 cm	14 cm	16 cm
Leaf Width	7-8 cm	6 cm	7 cm	7 cm
Leaf Color	Green	Green	Green	Green
Stem Color	Brown	Brownish Green	Brownish	Brownish Green

Source: *) Direktorat Perbenihan Hortikultura (2022)

Table 6. shows the results of qualitative data analysis which includes leaf length, leaf width, leaf color, and stem color. Then the plants studied were matched using a tool, namely the RHS Color Chart. The results of the analysis using the RHS Color Chart on the scion varieties of Manalagi showed that the leaf color variable met the recommended standards. In the Gedong Gincu scion variety, it shows that those that meet the recommended standards are in the variables of leaf width, leaf color, and stem color. The Okyong scion variety shows that those that meet the recommended standards are in the leaf width and leaf color variables

This qualitative data is obtained by matching the plants that have been planted and examined which are then matched to a tool to ensure that the plants planted are the desired type of plant. This indicates whether the plant currently grown is of the desired variety. From the results of observations made on Manalagi, Gedong Gincu, and Okyong mango varieties in line with research on leaf length and leaf width that has been carried out by Rebin et al. (2020) that the description of the results regarding the length and width of the leaves was not caused by the influence of the varietal treatment that occurred but due to genetic influences that also occurred, where the mango varieties used were Garifta Merah, Agri Gardina 45, and Gadung. The opinion of Rebin et al. (2020) concerning leaf color and stem color in mango plants that have been given treatment, shows that the color seen in these parts, the difference in leaf color and stem color, can be due to the influence of the plant's genetics.

CONCLUSION

The results of this study conclude that the highest percentage of growing seedlings was found in the scion variety of Manalagi at 91.7%. In the variable plant height, there was a significant difference in the weeks after grafting 1st, 2nd, 3rd, 4th, 7th, 8th, 9th, and 10th to differences in scion varieties. In the variable number of leaves, shoot length, and scion diameter each week there was no significant difference in the difference in scion varieties. Based on the average yield of the highest plant height found in the scion variety of Gedong Gincu mango. The highest number of leaves was found in the scion variety of Manalagi mango. Meanwhile, the highest shoot length and scion diameter were found in the Okyong scion variety. The results of the analysis using the RHS Color Chart on the scion varieties of Manalagi indicated that the leaf color variable met the recommended standards. In the Gedong Gincu scion variety, it shows that those that meet the

recommended standards are in the variables of leaf width, leaf color, and stem color. The Okyong scion variety shows that those that meet the recommended standards are in the leaf width and leaf color variables.

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