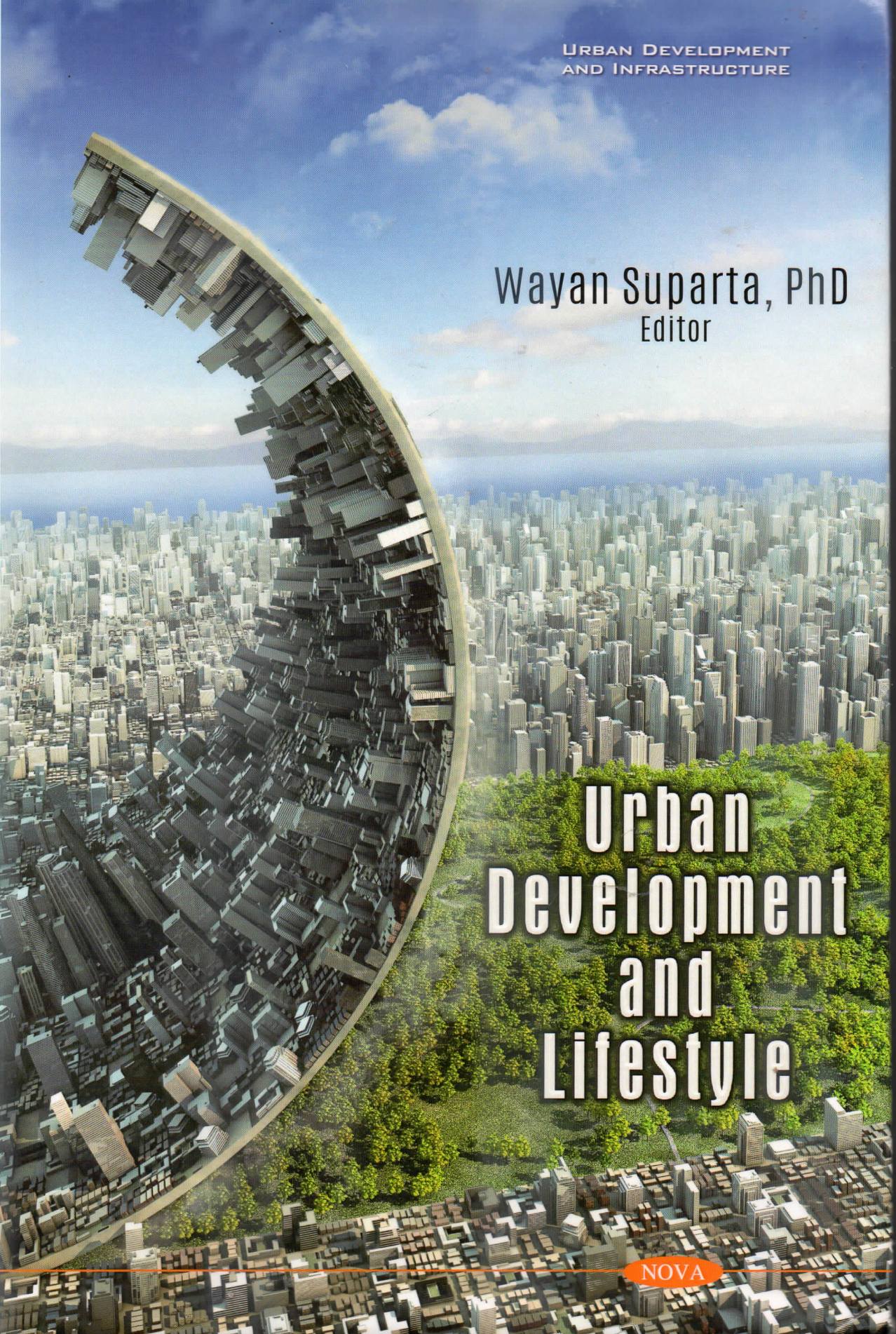
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Chapter 29

INCREASING THE PERFORMANCE OF BOUGAINVILLEA WITH TOP GRAFTING FOR THE GREEN LINE IN URBAN ENVIRONMENT

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ABSTRACT

Green line is the main element of vegetation known to naturally function as an atmospheric cleaner by absorbing pollutants in the form of gases and particles through leaves. These characteristics are seen in bougainvillea, which is a recommended tolerant ornamental plant. Generally, *bougainvilleas* are propagated with grafting for increasing their performance. The technique of grafting involves merging the rootstock with the scion of a different plant, leading to the formation of a union that continues to grow into new plants. The purpose of this study, therefore, was to determine the best type of top grafting on the performance of *bougainvillea*, conducted in the experimental garden, Faculty of Agriculture, UPN "Veteran" Yogyakarta between October and December 2019. In addition, the site was located on altitude 191 m above sea level, and the experiment involved the use of Completely Randomized Design (CRD) with three top grafting treatments, encompassing cleft, slash, and side grafting. Based on the results, it is concluded that grafting with the side method produces a better performance than the others, based on the number of days to sprout, as well as the longest shoot length, and shoot numbers. Furthermore, side techniques provided more percentage grafting to live, determined by linkage success between the scion and rootstock vessels of *bougainvillea* plant.

Keywords: cleft grafting, slash grafting, side grafting

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INTRODUCTION

Air pollution becomes a big problem in urban areas, it can disrupt the lives of human beings, animals and urban plants. This possibly interferes the health, as most of the high Pb metal concentrations in the air possess the capacity to alter the formation of red blood cells [1], and an effort to tackle this issue is by utilizing the ability of plants to absorb metal. For example, the adoption of green line is very important to overcome this pollution,, which involves planting pollutant tolerant species [2].

According to Indah et al. [3] stated that green line is a green area around the urban environment that aims to control development growth and maintain the green area. Green line refers to a vegetative area around an urban environment with the aims of controlling development, growth, and sustainability of the area. In addition, planting trees along the road leads to an improvement in air quality, and being the main element of vegetation, green line naturally functions as an atmospheric cleaner and living filter by absorbing pollutants in the form of gases and particles through the leaves. This is achieved through absorption, detoxification, accumulation and air metabolism regulation, subsequently causing enhanced air quality through the release of oxygen [4].

Angiospermae plants can be used as biomonitor which can detect gasseous pollutans, specially leaf is the most sensitive than the other part of plant. It may act as a pollution absorber in polluted environtment [5]. *Bougainvillea* is one of the ornamental plants recommended for pollutant tolerance, which climbs by releasing slender arching canes armed with stiff curved through the ages, with stems that changes from mid-green to dull green brown. Furthermore, *bougainvillea* is known to be deciduous in the long dry season areas [6], which has numerous cultivars with a striking array of colors. The results of a study of Nurhikmah et al. [7] recognized that the *bougainvillea* plants have the characteristics of high adaptation capacity towards air pollution.

Bougainvillea plants are preferred because of the colorful appearance of leaves and flowers, hence the *Bougainvillea variegate* species, generally propagated by grafting is preferred to *Bougainvillea spectabilis*, which proliferates with cutting. However, performing the process of grafting on *bougainvillea variegate* often leads to failure as a result of its less precise ability to take the scion. The technique of grafting involves merging the rootstock with the scion of a different plant, leading to the formation of a union that continues to grow into new plants. Basically, many forms of grafting have been adopted, depending on the plant variety used as a medium for propagation. This includes top grafting, which entails merging the scion with the rootstock to form a new plant, characterized by the capacity to adjust into one another in a complex manner [8].

The grafting type is an external factor that possibly influences the success rate, known to vary, including cleft, slash, and side grafting [9]. Meanwhile, the difference is observed in the way of cutting the scion and rootstock, as cleft has an excess of the scion, with a very strong rootstock. Conversely, the slash type has the disadvantage of being easily separated, while the side has the advantage of difficulty to remove. The results of a study by Yanti et al. [10] reported the occurrence of best response to the time of shoot rupture, number of leaves and stem diameter of durian plants after the cleft technique.

Allan et al. [11] reported the highest percentage of success (80%) by side grafting obtained after 15 weeks. The variation in results is influenced by different factors. The

successful union of scion and rootstock depend on the proliferation of callus tissue between graft components followed by the union of vascular tissues. This is influenced by factors such as incompatibility, plant species, type of graft, environmental conditions (e.g., temperature and moisture), and rootstock growth activity [12]. The purpose of this study was to determine the best type of top grafting on the performance of bougainvillea.

METHODS

This research was conducted in the experimental garden, Faculty of Agriculture, UPN "Veteran" Yogyakarta between October and December 2019, located at on latitude -7.740311 and longitude 110.441003, altitude 191 m above sea level. Furthermore, the mean daily maximum and minimum temperatures ranges between 26.5°C and 31.6°C, and relative humidity of 92% and 68%. In addition, the materials used in this experiment include the scion of *bougainvillea variegate*, rootstock of *bougainvillea spectabilis*, and growing media (soil and compost). Other tools used include cutter, plastic wrap, plastic-covered, label paper, and measuring.

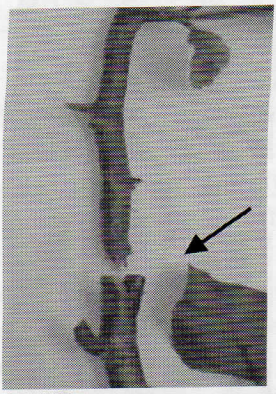

Figure 1. Cleft grafting.

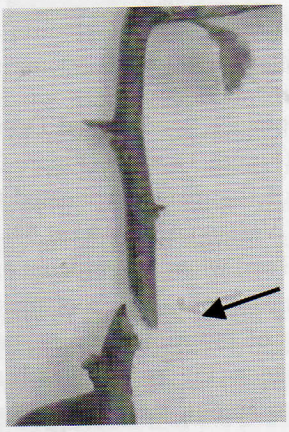

Figure 2. Slash grafting.

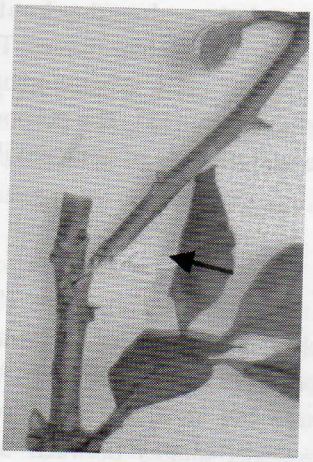

Figure 3. Side grafting.

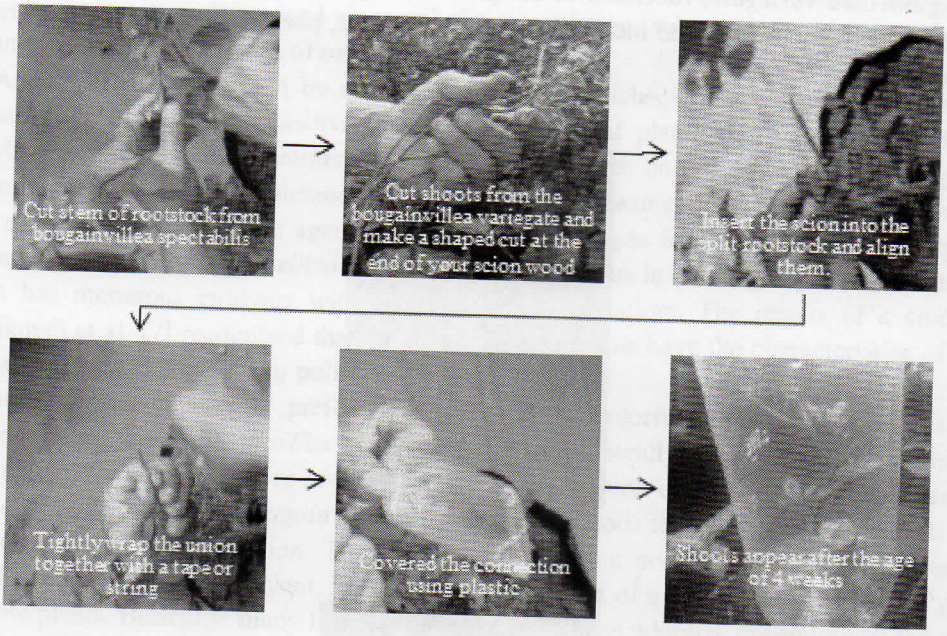

Figure 4. The process of of bougainvillea grafting treatment.

The experiment used a Completely Randomized Design (CRD) with three top grafting model treatments including cleft (Figure 1), slash (Figure 2), and side (Figure 3). In addition, each treatment involved the use of five plants replicated three times, and the data collected were evaluated using Analysis of Varian (ANOVA) at 5% significance level, continued with DMRT (Duncan Multiple Range Test) when a significant effect was observed.

The research included the preparation of the rootstock and scion, the implementation of top grafting including the cutting of the rootstock, incision of the scion, binding, labeling, covered with plastic, and maintenance (Figure 4). The observations were done on percentage grafting to live, number of days to sprout, length of longest shoot, and shoot number. Data collection techniques were carried out using a random sampling method on 5 plant samples of each 3 replications, the results presented are average.

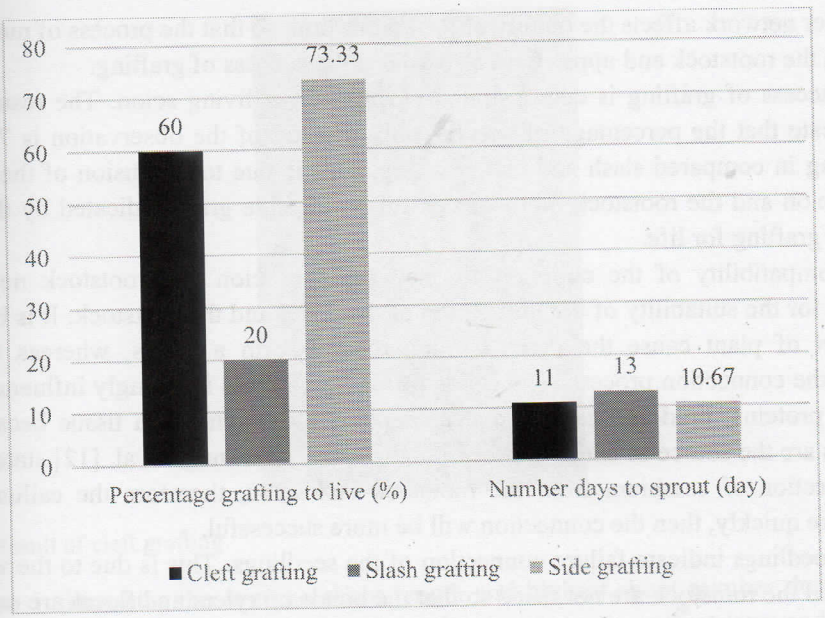

Figure 5. The graph of percentage grafting to live and number of days to sprout amongst bougainvillea species as influenced by top grafting model.

RESULT AND DISCUSSION

The analysis of variance revealed the significant effect of top grafting model on the growth of *bougainvillea*. Figure 5 indicates significant differences in the aspect of percentage grafting to live, and number of days to sprout. The side and cleft grafting produced more percentage grafting to live compared with the slash technique, which is an indication of success. This was calculated based on the amount of surviving plants after the process. It is often affected by the state of the surrounding environment.

In addition, the visual observation appears on the fresh green scion, not on the dark brown and wrinkled form with broken buds. According to Hartmann et al. [12], an increase in the cambium linkages from the rootstock and scion leads to a quicker formation of callus tissues, and an ultimate successful process. During callus formation, the density between the grafting components is very important because the strength of the grafting is related to the connection between the scion and the rootstock. Compatibility between the rootstock and scion also influence the success of grafting. According to Ashari [13], the influence of rootstock and scion, among others (1) to control the speed of growing the scion and the shape of the header, (2) to control the flowering, the number of shoots and the result of the scion, (3) to control the size of fruit, quality and efficacy of fruit, and (4) resistance to crop pests and diseases.

Sprouting is marked by the ability of the shoot length to reach 5 mm. This was faster with the side graft than others, probably due to the quick wound healing and callus formation in the rootstock and scion [14]. Sutarto et al. [15] stated the cambium linkage causes faster shoot and leaf formation. Hartmann et al. [12] stated that the availability of sufficient carbohydrates encourages a considerable production of callus. The merger of Callus allows the tissue transport restoration through the induction of analog-analog plants. The process of unification

of the carrier network affects the quality of the connection, so that the process of nutrients and water from the rootstock and upper stem also affects the success of grafting.

The success of grafting is demonstrated by number of living scion. The results of this study indicate that the percentage of success until the end of the observation is 73,33% on side grafting in compared slash and cleft grafting. This is due to the fusion of the cambium from the scion and the rootstock more successful on the side graft, indicated by the highest percentage grafting for life.

The compatibility of the cutting form between the scion and rootstock needs to be considered for the suitability of the unification of the scion and the rootstock. It is because of cutting part of plant cause the parenchyma tissue to form a callus, whereas the callus influences the connection process. The callus formation process is strongly influenced by the content of proteins, lipid and carbohydrates found in the parenchyma tissue because these compounds are the source of energy in forming the callus. Hartmann et al. [12] stated that the more connection of cambium from the rootstock and scion, therefore the callus tissue is formed more quickly, then the connection will be more successful.

Dead seedlings indicate failure connection of the seedlings. This is due to the wounds of the scion and the rootstock are not fused so that the bonds of xylem and floem are not formed. Furthermore, nutrients and water from the soil cannot be streamed to the upper stem and the opposite of photosynthesis is not transmitted to the rootstock organs. Firman and Ruskandi [16] stated that the percentage of successful connection is due to the inconsistency of the scion with the rootstock, whether the stem size, physiological age, forging or binding. It is also caused by the climate extreme, for example too much rain.

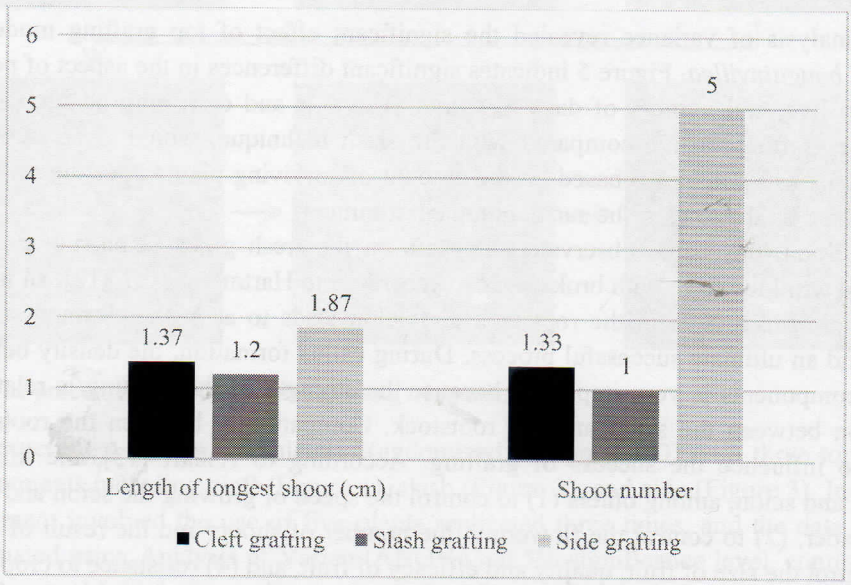

Figure 6. The graph of length of longesth shoot and shoot number amongst bougainvillea species as influenced by top grafting model.

Figure 7. Result of cleft grafting.

Figure 6. illustrates the average shoot length and highest shoot number during the side grafting treatment. The side grafting stimulates the transformation of nutrients and water to all part of the plant subsequently, it will affect other growth components, such as the leaves and the height of the plant. It is in the opinion of Sukarmin [17], when the connection has been perfectly linked then the plant can increase the absorption of nutrients and water from the soil for the needs of new cells in the growth of stem and the number of branches and leaves.

The growth rate of shoots is strongly influenced by carbohydrate availability. The leaves that have been formed will immediately perform photosynthesis. Thus, it will produce carbohydrates and growth regulators such as auxin and cytokine. The substance will be transferred through the water molecules to a special area such as tip buds. The cells in the area will multiply and extend the size resulting in a bud lengthening. The longer shoots will increase the number of leaves, so that more photosynthesis result and the amount of carbohydrates increases. While shoots as the center of endogenous auxin production will stimulate the root formation.

The number of shoots will give a positive response to the increase in production and the content of organic matter shows the growing quality plants [18]. According to Putri et al. [19], the shoot formation is more influenced by the growing hormone activity i.e., auxin and cytokine. An auxin and cytokine endogenous hormone will stimulate cell cleavage and differentiation to form new shoots. The mechanism of the auxin in influencing the extension of the plant cells can be explained as follows, auxin stimulate certain proteins that exist in the plasma membrane of plant cells to pump H^+ ions to the cell wall. The H^+ ion activates certain enzymes, so that break some of the chain hydrogen cross ties cellulose molecular constituent cell walls. Then the plant cells elongate due to the water coming in osmosis. After the extension, the cell continues to grow by resynthesizing the cell wall material and the cytoplasm.

Hartmann [12] affiliated the technique success with a combining ability, kinship and growth activity between scion and rootstock. In addition, Errea et al. [20]) stated if the translocation of nutrients, air, analog, enzymes as well as photosynthesis take place well between the scion and rootstock, the connection buds will grow faster. Sutarto et al. [15] established an association between the proper translocation of nutrients, water, hormones,

enzymes and photosynthesis in the scion and rootstock, with the fast growth of the shoot. The density between the grafting components is very important during callus formation because the graft strength influences the relationship between scion and rootstock, while compatibility affects the overall success of the process.

The linkage mechanism between the scion and the rootstock starts with the cambium layer of each plant cell forming a callus tissue in the form of parenchyma cells, which each other contact, fused and then diffuse, the formed parenchyma cells will be differentiated becomes cambium as a continuation of the scion and the old rootstock cambium. Furthermore, the cambium layer will form the vessel tissue so that the process of translocation nutrient from the stem down to the stem and vice versa for photosynthesis. Figures 7, 8, and 9, illustrate the result of cleft, slash and side grafting after 60 days.

Figure 8. Result of slash grafting.

Figure 9. Result of side grafting.

CONCLUSION

Based on the results and discussion, it is concluded that side method grafting gives the best performance than the others, based on the number of days to sprout, as well as the length of longest shoot, and shoot number. Furthermore, side and cleft techniques provided better percentage grafting to live, determined by linkage success between the scion and rootstock vessels of *bougainvillea* plant.

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