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Study of seed maturity level and duration of immersion in auxin solution on growth of *Anthurium hookeri* seedlings

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Abstract. *Prihandono S, Haryanto ET, Pujiasmanto B. 2020. Study of seed maturity level and duration of immersion in auxin solution on growth of Anthurium hookeri seedlings. Cell Biol Dev 4: 64-70.* Anthurium is one of the favorite indoor potted plants to decorate the room. One type of anthurium is *Anthurium hookeri* Kunth. The problem in anthurium cultivation is very slow plant growth. This study aimed to study the effect of seed maturity level and duration of immersion in auxin solution on the growth of *A. hookeri* seedlings. This study used a completely randomized design arranged in a factorial manner and consisted of two factors. The first factor is the level of maturity of the seeds (seeds aged 1-3 days after harvest, seeds aged 4-6 days after harvest, and seeds aged 7-9 days after harvest). The second factor was the duration of immersion (without soaking in the IAA solution, soaking for 15 minutes in the IAA solution, soaking for 30 minutes in the IAA solution, and soaking for 45 minutes in the IAA solution). The variables observed were germination variables (moisture content of seeds at harvest, germination fastness, germination potency, germination value, and germination unison) and growth variables (root length, seedling height, number of leaves, and leaf length). The data obtained on the germination variable were analyzed descriptively. In contrast, the data obtained on the growth variable was analyzed by the F test at the 5% level. If there was a significant difference, it was continued using Duncan's Multiple Distance Test (DMRT) at the 5% level. The results showed that on the germination variable, treatment of 1-3 days old seeds and soaking in IAA solution for 30 minutes gave better results than other treatments. Seed age treatment did not affect all growth variables except the number of leaves. The immersion treatment in the IAA solution only affected the number of leaves and did not affect other growth variables. There was an interaction between the treatment of seed age and immersion in the IAA solution on the variable of the number of leaves.

Keywords: Immersion duration, seed maturity level, seedling growth

INTRODUCTION

Ornamental plants in Indonesia still have very potential market prospects to be developed in type and variety. Therefore, opportunities to develop ornamental plant cultivation are useful to meet domestic and foreign needs. In addition, ornamental plant agribusiness will be able to encourage the economy of the people who develop it (Sastrapradja 1975).

Anthurium is a tropical ornamental plant with high appeal as a room decorator because of its beautiful leaf and flower shape. Types of anthurium in terms of aesthetics are classified into two: flower-type of anthurium and leaf-type of anthurium. The leaf type of anthurium is one of the favorite indoor potted plants to decorate the room (Chen et al. 2004; Henny and Chen 2004). One type of leaf type of anthurium is *Anthurium hookeri* Kunth.

Anthurium hookeri is an ornamental plant with high appeal as a room decoration because of its beautiful leaf and flower shape. This plant is in great demand by consumers and has high economic value, so it is very potential to be developed. Demand for various species of anthurium is currently very high and demands good plant quality. Some of the criteria consumers want are broad-leaved plants with a large number of leaves and tough and fresh plants. The quality of this plant is very influential on the selling price of the plant (Sakya et al. 2008).

Anthurium hookeri is a flowering plant species belonging to the genus *Anthurium*. Almost typically, the specimens sold are hybrids and not the species. *A. hookeri* is a unique plant because it has short internodes, dense roots, and cataphylls shaped like lances. The stems of the leaves are either triangular or D-shaped and are 2-9 cm long. The leaves are rosulate, 10-26 cm wide and 35-89 cm long. The veins on the leaves are scalariform and supervolute. There are tiny black glands all over the leaves. The white berries that the plant produces are easy to spot. *A. hookeri* has a plain inflorescence that spreads out and hangs down along with the blue spadix, which stands straight up. The spathe is cylinder-shaped and green with a hint of purple. Most people think the seed berries on the infructescence are red, but they are oval or oblong and not red. *Anthurium* species are known to have a lot of differences, and not every leaf on every plant will look the same. However, the sexual traits stay the same (https://www.exoticrainforest.com/Anthurium%20hookeri%20pc.html).

Anthurium hookeri loves humid environments. Since epiphytes normally do not have soil-based roots, it also requires very well-draining soil to thrive. The roots are linked to the host tree and hang in the air. Therefore, this plant is suitable for planting in soil that dries quickly and does not retain moisture (https://www.exoticrainforest.com/Anthurium%20hookeri%20pc.html)

The problem in cultivating *A. hookeri* or other types of Anthurium is that plant growth is very slow. Some obstacles faced in anthurium nurseries are the slow growth of sprouts and seedlings, many dead seeds, abnormal growth of sprouts, and non-uniform growth of sprouts and seedlings. Several alternative ways to overcome these problems include ripe seeds in the nursery and immersing the seeds in a phytohormone solution. One solution to be used is auxin. Chemically ripe seeds have sufficient food reserves and a perfect embryo so that they are ready to germinate. In addition, immersing seeds in auxin allows stimulation of somatic embryos in the formation of shoots and roots more quickly and uniformly (George et al. 2008; Liu et al. 2013).

This research aimed to study the effect of seed maturity level and soaking duration in auxin solution on the growth of *A. hookeri* seedlings.

MATERIALS AND METHODS

This research was conducted in Margorejo, Gilingan, Banjarsari, Surakarta, Central Java, Indonesia, at an altitude of 97 masl. This research started from March 2009 to May 2009.

This study used a completely randomized design (CRD) which was arranged in a factorial manner and consisted of two factors. The first factor was the level of maturity of the seeds (seeds aged 1-3 days after harvest, seeds aged 4-6 days after harvest, and seeds aged 7-9 days after harvest). The second factor was the duration of immersion (no immersion, immersion for 15 minutes in IAA solution with a concentration of 100 ppm, immersion for 30 minutes in IAA solution with a concentration of 100 ppm, and immersion for 45 minutes in IAA solution with a concentration of 100 ppm). Thus, 12 treatment combinations were obtained. Each treatment combination was repeated 3 times so that 36 experimental pots were obtained.

The variables observed were germination variables (moisture content of seeds after harvest, germination fastness, germination potency, germination value, and germination unison) and growth variables (root length, seedling height, number of leaves, and leaf length). The data obtained on the germination variable were analyzed descriptively. In contrast, the data obtained on the growth variable was analyzed by the F test at the 5% level. If there was a significant difference, it was continued using Duncan's Multiple Distance Test (DMRT) at the 5% level.

RESULTS AND DISCUSSION

Seed water content after harvest

Water content is weight loss when the seeds are dried according to a certain technique or method. Determining a group of seeds' water content is very important. It is related to the success of germination because water content influences a seed's rate of decline. Within a certain limit, the lower the water content of the seed, the longer the viability of the seed.

The maturity level of anthurium seeds affects the water content of the seeds to be sown. For example, Table 1 shows that the seeds aged 1-3 days after harvest have a water content of 33%, the seeds aged 4-6 days after harvest have a moisture content of 34%, and the seeds aged 7-9 days after harvest have a water content of 35%. It also shows that the longer the harvest, the higher the water content. It is thought to be in line with the harvesting process, which gradually increases rainfall. So, the water content of the fruit increases and affects the water content of the seeds as well.

The germination process and growth are strongly influenced by the availability of water in the seed and water in the growth medium for absorption and stimulating the activity of enzymes for germination metabolism in the seed. Therefore, water content that is too high can cause seeds to germinate before planting. Besides, the too-high water content can stimulate the development of pathogens in the storage area, but keep in mind that too-low water content will cause damage to the embryo (Sutopo 1985).

Germination fastness

Technically, germination is the beginning of active growth that produces seedlings. During germination, biochemical, physiological, and morphological changes occur. Through these reactions, the food reserves in the seeds are broken down, which are then used for the formation and growth of parts of the sprouts, such as the plumule and radicle. Unfavorable sub-optimum conditions in the field can increase the seeds' weakness, decrease the germination percentage, and slow seed growth. Therefore, it is necessary to test the germination fastness. According to Sadjad (1974), in Sutopo (1985), the speed of growth indicates a fast-growing seed will be better to face sub-optimum field conditions.

Table 2 shows that *A. hookeri* seeds have a low mean germination fastness. Plant genetic factors caused it. It was per the opinion of Heydecker (1972) in Sutopo (1985), which states that certain cultivars are more sensitive to unfavorable environmental conditions. Unsuitable environmental conditions can result in a decrease in seed vigor. Low seed vigor can result in a decrease in the fastness of seed germination. Although the average seed germination fastness of *A. hookeri* was relatively low, the treatment of a 1-3 days old seed and immersion in IAA solution for 30 minutes gave a better percentage of germination fastness than other treatments.

Table 1. The water content of seeds at harvest

Seed age	Water content (%)
1-3 days after harvest	33
4-6 days after harvest	34
7-9 days after harvest	35

Table 2. Average germination fastness of *Anthurium hookeri*

No immersion (days old)		Immersion for 15 minutes	Immersion for 30 minutes	Immersion for 45 minutes	Average
1-3	30.00	23.30	43.30	36.70	33.32
4-6	23.30	36.70	23.30	26.70	27.50
7-9	10.00	13.30	30.00	23.30	19.15
Average	21.10	24.40	32.20	28.90	

Seed aged 1-3 days gave a better germination fastness than the treatment of 4-5 days or 7-9 days of seed age. Seeds aged 1-3 days are suspected of having the lowest water content among other treatments. Water content is very influential on germination; with excessive seed water content, the level of water absorption at the time of germination cannot be optimal because, during the ripening period of the seed, water is reduced or lost from the seed. Still, for germination, it is necessary to add water again. Although according to Kamil (1979), the water absorbed by the seeds is useful for softening the seed coat and causing rupture or tearing, water is also useful in diluting the protoplasm to activate various functions of the protoplasm. Moreover, water can also stimulate the activity of enzymes for germination metabolism in seeds.

The treatment of immersion in IAA solution affects the fastness of seed germination so that the seeds can produce more sprouts. The immersion in the IAA solution for 30 minutes resulted in a better percentage of germination fastness than the immersion treatment for 15 minutes and 45 minutes. It is suspected that at the time of immersion for 30 minutes, the amount of absorbed IAA had reached the optimum concentration for the plant's growth, so adding more auxin at 45 minutes decreased germination's fastness. According to Wilkins (1989), the hormone auxin increases growth until it reaches an optimal concentration. Still, if the concentration exceeds optimal, it will interfere with plant metabolism and development.

Germination potency

Seed germination potency provides information to seed users on the ability of seeds to grow normally into plants that produce reasonable yields under optimum field biophysics conditions.

The germination test is to germinate the seeds under conditions suitable for the germination needs of the seeds, then calculate the percentage of seed germination. The germination percentage is the number of proportions of seeds that have produced germination under certain conditions and periods. The purpose of the germination test was to obtain information on the value of planting seeds in the field that had been treated with immersion in IAA solution and to compare seed quality between seed groups.

Table 3 shows that *A. hookeri* seeds have a low average germination potency (<70%). As with the variable of germination fastness, the low germination potency was caused by plant genetic factors that decreased seed vigor and viability. Although the average normal germination potency of *A. hookeri* seeds was low, treatment of 1-3 days old seed and immersion in IAA solution for 30 minutes gave a better germination fastness than the other treatments.

Treatment of 1-3 days old seeds gave better germination results than treatments of 4-5 days old or 7-9 days old. It is related to the water content of seeds. 1-3 days old seeds have the lowest water content compared to other treatments. According to Kuswanto (2003), at high water content, seed respiration runs faster. It produces heat which will increase the temperature of the seed so that the seed will rapidly decrease vigor and viability. With lower moisture content, the seeds could undergo normal germination because of the higher viability of the seeds.

The treatment of immersion in IAA solution for 30 minutes and 45 minutes affected the germination of the seeds so that the seeds could produce more normal sprouts. The treatment of immersion in IAA solution for 30 minutes gave a better percentage of normal germination than the treatment of immersion for 45 minutes. It is assumed that at the time of immersion for 30 minutes, the amount of absorbed IAA had reached the optimum concentration to encourage germination. PGR from the auxin group at the right concentration can stimulate cell division. It is suspected that cell division occurred at this concentration; cell permeability and water absorption by seeds increased so that seed food reserves could be broken down for the seed germination process.

Germination value

The germination value is the multiplication of the peak value with the average value of daily germination. The peak value is the percentage of germination at the time the germination fastness begins to decrease, divided by the number of days required to reach it. The average daily germination is the percentage of germination at the stop point of the percentage of germination divided by the total test days (Sutopo 1985).

Table 4 shows that the treatment of 1-3 days old seeds and immersion in IAA solution for 30 minutes gave a better average germination value than the other treatments. In addition, the treatment of immersion in IAA solution for 30 minutes gave a better average germination value than the treatment of immersion for 15 minutes or 45 minutes. However, it is suspected that at the time of immersion for 30 minutes, the amount of absorbed IAA had reached the optimum concentration for the plant's growth, so adding more auxin at 45 minutes decreased the germination value.

Table 3. Average germination potency of *Anthurium hookeri*

No immersion (days old)		Immersion for 15 minutes	Immersion for 30 minutes	Immersion for 45 minutes	Average
1-3	70.00	53.30	83.30	66.70	68.33
4-6	40.00	66.30	56.70	66.70	57.43
7-9	60.00	50.00	66.70	50.00	56.68
Average	56.67	56.53	68.90	61.13	

Table 4. Average germination value of *Anthurium hookeri*

No immersion (days old)		Immersion for 15 minutes	Immersion for 30 minutes	Immersion for 45 minutes	Average
1-3	24.40	27.50	30.50	28.50	27.70
4-6	27.50	19.80	27.50	29.50	26.08
7-9	25.40	28.50	29.00	27.50	27.60
Average	25.77	25.27	29.17	28.50	

Table 5. Average germination unison of *Anthurium hookeri*

No immersion (days old)		Immersion for 15 minutes	Immersion for 30 minutes	Immersion for 45 minutes	Average
1-3	66.70	50.00	80.00	63.30	65.00
4-6	40.00	60.00	56.70	63.30	55.00
7-9	56.70	46.70	60.00	46.70	52.53
Average	54.47	52.23	65.57	57.77	

Treatment of seeds aged 1-3 days gave a better germination value than the treatment of seeds aged 4-5 days or 7-9 days. It is suspected that seeds at the age of 1-3 days have the lowest water content among other treatments. Moisture content is very influential on germination. Excessive seed moisture content will cause the level of water absorption at the time of germination to not take place optimally because, during the ripening period of the seeds, water is reduced or lost from the seeds. On the contrary, for germination, additional water is needed. It is clarified by Kamil (1979) that the water absorbed by the seeds is useful for softening the seed coat and causing the seed coat to break or tear. It is also useful in diluting the protoplasm so that it can activate various functions of the protoplasm. Besides, water can also stimulate the activity of enzymes for germination metabolism in seeds.

Germination unison

Germination unison is influenced by the seed's size, weight, and physiological maturity. In addition, it is related to the amount and content of organic matter in the seeds needed in the germination process (Mugnisjah 1994).

Table 5 shows that the treatment of seeds aged 1-3 days and immersion in IAA solution for 30 minutes gave a better average germination unison than other treatments. In addition, the treatment of immersion in IAA solution for 30 minutes gave a better average of germination unison than the treatment of immersion for 15 minutes or 45 minutes. However, it is suspected that at the time of immersion for 30 minutes, the amount of absorbed IAA had reached the optimum concentration for the plant's growth, so adding more auxin in 45 minutes' immersion treatment decreased the germination unison.

In the treatment of seed age, the older age of seeds led to a lower average of germination unison. Seeds aged 1-3 days had better germination unison compared to treatments of seeds aged 4-5 days or 7-9 days. It is suspected that seeds at the age of 1-3 days have the lowest water content among other treatments. According to Kuswanto (2003), at high water content, seed respiration runs faster. During the respiration process, heat is generated, which will increase the temperature of the seed, so the seed will rapidly decrease both vigor and viability. With lower moisture content, the seeds could undergo normal germination because of the higher viability of the seeds.

Germination unison is also influenced by the level of maturity of the seeds. Still, this study was not too influential because all the seeds used had reached physiological maturity. The maturity level affects the amount and type of food reserves. Three kinds of food substances affect germination and growth: carbohydrates, fats, and proteins. Carbohydrates are the largest part of seeds. They function as a source of energy needed for growth and germination. Fat is found in the vegetative and reproductive organs but mostly in seeds as a food reserve that serves as a source of energy for growth. Protein is a food substance in seeds and functions as a protoplasm former at the beginning of growth (Kamil 1979). According to Sutopo (1985), seed food reserves influence seed viability. If the content of food reserves in the food network is too small in number and variety, then the viability of the seeds is low at harvest time.

Root length

Roots are one of the most important plant organs supporting plant growth. Roots function as an absorber of nutrients contained in the planting medium. Long roots will expand the area of nutrient absorption so that the distribution of nutrients from the planting medium to the plants can run smoothly. In addition, the roots serve as a reinforcement for the establishment of the plant.

From the analysis of variance, it was found that the treatment of seed age and immersion in IAA solution had no effect on root length, and there was no interaction between seed age and immersion time on root length. It is presumably because the concentration of endogenous IAA in seedlings is already optimum to stimulate the division and elongation of cells in the roots, so adding IAA will inhibit root elongation. Per the opinion of Salisbury and Ross (1995), the application of relatively high concentrations of IAA to the roots will cause inhibition of root elongation but increase the number of roots. On the other hand, IAA can promote root elongation at very low concentrations.

Inhibition of root growth is strongly influenced by endogenous control in plants. This inhibition is not only caused by the concentration of auxin, which is too high, but also by root inhibitor compounds in the form of phenol and manganese compounds (Jarvis 1986). Phenol compounds, namely monophenols and manganese (Mn^{2+}), are important cofactors in the activity of the IAA oxidase enzyme (Krisnamoorthy 1981). Monophenol is a growth inhibitory substance because it affects increasing IAA oxidase activity so that it will reduce the auxin content in the plant body.

Although statistically, the results of the analysis showed that the results were not significantly different, there was a tendency for the best mean root length to be obtained in the treatment without immersion in IAA solution and seed age of 4-6 days (Table 6).

Table 6. Average root length of *Anthurium hookeri* at 12 WAP

No immersion (days old)		Immersion for 15 minutes	Immersion for 30 minutes	Immersion for 45 minutes	Average
1-3	9.10	8.90	9.50	7.00	8.63
4-6	9.50	8.50	8.50	8.20	8.68
7-9	8.00	7.80	7.50	7.60	7.73
Average	8.87	8.40	8.50	7.60	

Table 7. Average seedling height of *Anthurium hookeri* at 12 WAP

No immersion (days old)		Immersion for 15 minutes	Immersion for 30 minutes	Immersion for 45 minutes	Average
1-3	3.60	3.50	3.10	3.30	3.38
4-6	4.20	3.70	3.30	3.70	3.78
7-9	3.20	3.40	3.50	3.90	3.50
Average	3.67	3.53	3.30	3.63	

Seedling height

Seedling height is a plant size often observed both as a growth indicator and as a parameter to measure the effect of the treatment. So, it is because plant height is the most easily observed growth measure (Sitompul and Guritno 1995). From the analysis of variance, it was found that the treatment of seed age and immersion in IAA solution had no effect on seedling height, and there was no interaction between seed age and soaking time on seedling height. It is thought to be due to the relatively high concentration of IAA used. The main site of auxin synthesis in plants is in the apical meristem of the tip of the shoot. IAA produced in the shoot tip is transported to the bottom and promotes the elongation of stem cells. IAA promotes stem cell elongation only at a certain concentration of 0.9 g/l. Above this concentration, IAA will inhibit stem cell elongation. This inhibitory effect probably occurred because the high concentration of IAA resulted in plants synthesizing other PGRs, namely ethylene, which gave the opposite effect to IAA (Purwanto 2006).

It is clarified by Salisbury and Roos (1995) that auxin is effective at a certain amount. Concentrations that are too high can damage. Otherwise, concentrations below the optimum are ineffective. According to Wilkins (1989), the hormone auxin increases growth until it reaches an optimal concentration, but if it is higher than the optimal concentration, metabolism and plant development will be disrupted.

Although the analysis showed that the results were not significantly different, there was a tendency for the best seed height to be obtained in the treatment of no immersion and seeds aged 4-6 days (Table 7).

Number of leaves

The beauty of the leaves is one of the attractions of the *A. hookeri* plant. However, *A. hookeri* growth is very slow, characterized by a slow increase in the number of leaves. According to Gardner et al. (1991), leaves are carbohydrate factories for cultivated plants, where leaves are needed for absorption and converting sunlight through photosynthesis, which is used for plant growth and development. Therefore, the number of leaves indicator can be used as supporting data to explain the growth process. From the analysis of variance, it was found that the treatment of seed age and immersion in IAA solution had a significant effect on the number of leaves, and the interaction between the two treatments had a very significant effect on the variable number of leaves of *A. hookeri*.

The immersion treatment was related to the IAA absorption process that occurred on the entire surface of the seeds. According to Lakitan (1996), the absorption process in plant cells is influenced by the permeability of the cell membrane and the difference in water potential between the inside and outside the cell. Therefore, absorption by plant cells will increase the turgor pressure in the cells, which in turn will cause cell enlargement.

IAA can enter plant cells because the cell membrane contains auxin receptors in the form of proteins (Salisbury and Roos 1995). IAA enters through the cell membrane by osmosis, where water can diffuse from a solution with a high potential to a low potential until it reaches the same water potential (Campbell et al. 2002).

Table 8 shows the highest average number of leaves obtained in the treatment of no immersion, namely 4 leaves. The lowest average number of leaves was found in the immersion treatment for 15 minutes, as many as 3.33 (3 blades). The treatment of no immersion was significantly different from the treatment of immersion for 15 minutes. The immersion treatments for 30 minutes or 45 minutes resulted in an average number of leaves that were not significantly different from the other two treatments. The condition showed that the immersion treatment for 30 minutes or 45 minutes produced the same number of leaves when the seeds were soaked for a shorter time, although the treatment of no immersion produced the highest number of leaves.

Auxin is a growth hormone that is inseparable from the process of plant growth and development. This compound can support cell elongation in shoots. By providing growth regulators, auxin can stimulate roots, affecting shoot growth and leaf formation (Soedjono 1997). However, in this study, the IAA immersion treatment did not provide a better plant response than the control. It was because the endogenous hormone content was optimal to stimulate the process of cell division and cell differentiation. The supply of hormones from outside can stimulate plant physiological processes, but the response depends on the level of endogenous hormones (Hidayanto et al. 2003).

Table 9 shows the highest average number of leaves was obtained in the treatment of seeds aged 1-3 days and ages 4-6 days, while the lowest average number of leaves was found in the treatment of seeds aged 7-9 days. Treatment of seeds aged 1-3 days was not significantly different from those aged 4-6 days, but the two treatments differed significantly from those aged 7-9 days. The seeds aged 7-9 days had higher moisture content than the other two treatments. According to Kuswanto (2003), at high water content, seed respiration runs faster, and heat is generated during the respiration process, which will increase the seed's temperature, so the seed will rapidly decrease both vigor and viability.

Sutopo (1985) states that high water content can cause respiratory activity to increase, which can cause food reserves in the seeds to be depleted so that the vigor and viability of the seeds decrease. Therefore, seeds that have low vigor can cause a decrease in plant production. It can be seen in the average number of leaves of seeds aged 7-9 days which is lower than the average number of leaves in the treatment of seeds aged 1-3 days and seeds aged 4-6 days.

Leaf length

Leaves are very important organs for plants. Leaves are needed to absorb and convert light energy to grow and produce crops. Leaf length is one component of the leaf. From the analysis of variance, it was found that the treatment of seed age and immersion in IAA solution had no effect on leaf length, and there was no interaction between seed age and soaking time on leaf length. It is presumably due to the nature of the IAA itself, which is easy to spread to other parts, so the IAA's effectiveness is lost. Another possibility is that IAA is basipetal (moving towards the base), accumulating in the roots and affecting root formation (Gardner et al. 1991).

Table 8. The average effect of immersion time on the number of leaves of *Anthurium hookeri* at 12 WAP

Treatment	Number of the leaf (blade)
IAA immersion for 0 minutes	4.00 a
IAA immersion for 15 minutes	3.33 b
IAA immersion for 30 minutes	3.56 ab
IAA immersion for 45 minutes	3.56 ab

Note: Numbers followed by the same letter are not significantly different at the 5% level of DMRT

Table 9. The average effect of seed age on the number of leaves of *Anthurium hookeri* at 12 WAP

Treatment	Number of the leaf (blade)
Seeds aged 1-3 days	3.75 a
Seeds aged 4-6 days	3.75 a
Seeds aged 7-9 days	3.33 b

Note: Numbers followed by the same letter are not significantly different at the 5% level of DMRT

Table 10. Average leaf length of *Anthurium hookeri* at 12 WAP

No immersion (days old)		Immersion for 15 minutes	Immersion for 30 minutes	Immersion for 45 minutes	Average
1-3	4.50	3.20	4.10	3.10	3.73
4-6	5.00	3.80	3.00	3.30	3.78
7-9	3.50	2.80	3.20	3.40	3.23
Average	4.33	3.27	3.43	3.27	

Although the analysis showed that the results were not significantly different, the best trend in the mean leaf length was found in the treatment of no immersion and seeds aged 4-6 days (Table 10). Compared with the control, the plants showed a decrease in leaf length. Endogenous auxin content in seedlings was sufficient for seedling growth, so immersion in IAA with a concentration of 100 ppm could not provide a better growth effect. However, giving IAA can stimulate leaf cell enlargement. By giving the right concentration, the growth activity of cell enlargement becomes higher (Purwanto 2006).

Based on the research, it can be concluded: (i) treatment of seeds aged 1-3 days and immersion in IAA solution for 30 minutes gave better results than other treatments on germination variables; (ii) treatment of seeds age only affects the number of leaves variable. Therefore, the long age of seeds leads to a decrease in the number of leaves; (iii) the immersion treatment in IAA solution only had an effect on the variable number of leaves but had no effect on other growth variables. Therefore, the longer immersion time will produce a lower number of leaves; (iv) there is an interaction between the treatment of seed age and immersion in IAA solution on the variable number of leaves.

REFERENCES

Anon. 2002. Cemerlangnya Prospek Anthurium. Trubus Swadaya, Jakarta. [Indonesian]

Campbell NA, Reece JB, Mithcell LG. 2002. Biologi. Alih Bahasa:Wasmen Manalu. Erlangga, Jakarta. [Indonesian]

Chen J, Henny RJ, Robinson CA, Mellich T, Caldwell RD. 1999. Potted Anthurium: An interior-flowering foliage plant. Proc Florida State Hort Soc 112: 280-281.

Gardner FP, Pearce RB, Mitchell RL. 1991. Fisiologi Tanaman Budidaya. Universitas Indonesia, Jakarta. [Indonesian]

George EF, Hall MA, De Klerk GJ. 2008. Plant Propagation by Tissue Culture. Volume 1: The Background. Springer, The Nederlands.

Henny RJ, Chen J. 2004. Cultivar development of ornamental foliage plants. Plant Breed Rev 23: 245-290.

Heydecker W. 1972. Vigour in Viability of Seeds. Chapman & Hall Limited, New Delhi. DOI: 10.1007/978-94-009-5685-8_8.

Hidayanto M, Nurjanah S, Yossita F. 2003. Pengaruh panjang stek akar dan konsentrasi natrium nitrofenol terhadap pertumbuhan stek akar sukun (*Artrocarpus communis* F.). J Pengkajian dan Pengembangan Teknologi Pertanian 6 (2):154-160. [Indonesian]

Jarvis BC. 1986. Endogenous control of adventitious rooting in non woody cuttings. In New Root Formation in Plants and Cuttings. Martinus Nijhoff Publishers, Dordrecht. DOI: 10.1007/978-94-009-4358-2_6.

Kamil J. 1979. Teknologi Benih. Angkasa Raya, Padang. [Indonesian]

Krisnamoorthy NH. 1981. Plant Growth Substances Including Applications in Agriculture. Mc Graw Hill Publishing Company Limited, New Delhi.

Kuswanto H. 2003. Teknologi Pemrosesan Pengemasan dan Penyimpanan Benih. Kanisius, Yogyakarta. [Indonesian]

Lakitan B. 1996. Fisiologi Pertumbuhan dan Perkembangan Tanaman. Raja Grafindo Persada, Jakarta. [Indonesian]

Liu X, Zhang H, Zhao Y, Feng Z. 2013. Auxin controls seed dormancy through stimulation of abscisic acid signaling by inducing ARF-mediated ABI3 activation in *Arabidopsis*. Proc Natl Acad Sci 110(38). DOI: 10.1073/pnas.1304651110.

Mugnisjah WQ. 1994. Panduan Praktikum dan Penelitian Bidang Ilmu Teknologi Benih. Raja Grafindo Persada, Jakarta. [Indonesian]

Purwanto AW. 2006. Sansiviera: Flora Cantik Penyerap Racun. Kanisius, Yogyakarta. [Indonesian]

Sadjad S. 1974. Teknologi Benih dan Masalah Uji Viabilitas Benih. Institut Pertanian Bogor, Bogor. [Indonesian]
Sakyai AT, Rahayu M, Wijayanti R. 2008. The growth and quality of *Anthurium hookeri* on various boron application. Sains Tanah - Jurnal Ilmiah Ilmu Tanah dan Agroklimatologi 5 (2): 95-99. [Indonesian]
Salisbury FB, Ross CW. 1995. Fisiologi Tumbuhan Jilid 2. ITB Press, Bandung. [Indonesian]
Sastrapradja S. 1975. Potential and prospects of ornamental plants in Indonesia. Lokakarya Industri Bunga. Jakarta, Indonesia, 4 Desember 1975. [Indonesian]
Sitompul SM, Guritno B. 1995. Analisis Pertumbuhan Tanaman. Gadjah Mada University Press, Yogyakarta. [Indonesian]
Soedjono S. 1997. Pemberian Air Kelapa, GA3, dan grenzil pada umbi gradiolus yang dibelah. J Hort 5 (2): 79-89. [Indonesian]
Sutopo L. 1985. Teknologi Benih. Radjawali Press, Jakarta. [Indonesian]
Wilkins MB. 1989. Fisiologi Tanaman. Alih Bahasa: Sutedjo MM, Kartasapoetra AG. Bina Aksara, Jakarta. [Indonesian]