Betung Bamboo Shoot (Dendrocalamus asper Backer ex Heyne) Extracts: Accelerating the growth of Java Apple (Syzygium samarangense) stem cuttings

S Mulyaningsih*, D Sumiati, H Hernawan, R Robbiyani, S Sriwahyuningsih
Prodi Pendidikan Biologi, Institut Pendidikan Indonesia, Jalan Pahlawan No32, Garut 44151, Jawa Barat, Indonesia

*srimulyaningsih65@gmail.com

Abstract. The pruning waste of Java Apple (Syzygium samarangense) tree branch can be used for its propagation by stem cuttings. The rooting process can be accelerated with the help of growth regulators, one of which is betung bamboo shoot extract. Using a randomized block design, this experiment aims at examining the effect of betung bamboo shoot extract with concentrations of 0%, 10%, 20%, 30%, 40% and 50% on the growth of Java Apple stem cuttings. The samples were 48 stem cuttings with a diameter of 1 cm and a length of 15 cm. The results showed that betung bamboo (Dendrocalamus asper) extracts could accelerate the propagation process. The optimum concentration was 50%.

1. Introduction
Java apple is one of the most nutritious fruit plants, so it is very popular with most Indonesian people. The nutritional content in 100 grams of guava fruit contains 46 calories, 0.60 grams of protein, 0.20 grams of fat, 11.80 mg of carbohydrates, 7.5 mg of calcium, 8 mg of phosphorus, 1.1 mg of iron 5 grams of vitamin C, 87 gr of water (Directorate of Nutrition, Ministry of Health of the Republic of Indonesia in 1981 [1]. In addition, Java Apple contains flavonol glycosides, flavonol di-glycosides, and flavones and ellagitannin and phenolic acids [2,3]. Java Apple extract also shows antioxidant activity [4,5]. Whereas, in Syzigium guineense shows antibacterial activity [6]. To maintain the quality of Samarang Java apple (Syzygium samarangense), branch pruning must be done at least once a year. Every pruning that can be used for seedlings because all parts of the branch can be rooted and sprout to reach 78.6%. To accelerate growth and increase the number of shoots produced on stem cuttings, growth regulators (ZPT) can be added. This growth regulation is carried out by the formation of hormones, influencing the hormone system, destruction of translocation or changes in the place of hormone formation [7]. Bamboo shoots are immature and edible bamboo stems arising from rhizomes [8]. Bamboo shoots have a very fast growth, because they are believed to contain growth supporting substances which have a high gibberelin content [9]. Further research stipulates that gibberellin or Gibberelic Acid (GA) is an important hormone for the development process in plants, including seed germination, cell elongation and organ enlargement through cell growth, trichome development, vegetative to reproductive transition, and the seed and fruit development discovered that GA3 increased the growth of Microcystis aeruginosa (Cyanophyta) by stimulating oxygen absorption and increasing the ability to use carbohydrates [10,11]. With the gibberellin content in bamboo shoots, it is expected that bamboo shoot extract water can be used to spur the growth of Java apple stem cuttings.
2. Methods and research problems

2.1. Research problems
The research problems are formulated as follows:
1) What is the effect of betung bamboo shoots (Dendrocalamus asper Backer ex Heyne) extract with different concentrations on increasing the growth of Java apple stem cuttings (Syzygium samarangense)?
2) And what is the optimum concentration for the growth of Java apple stem cuttings (Syzygium samarangense).

2.2. Methods
The method used in this research was an experimental method with Randomized Block Design (RBD). The treatment consisted of one control; (A) 0% concentration and five treatments; 10% (treatment B), 20% (treatment C), 30% (treatment D), 40% (treatment E) and 50% concentration (treatment F). The repetition was done 4 times. The sample was 48 Java apple stem cuttings with a diameter of 1 cm and a length of 15 cm.

The data collection techniques were carried out by systematically measuring the observed indicators. Observations were carried out at one-week intervals. The observed and measured variables were:

2.2.1. Shoot height (cm): measured by using a ruler starting from the base of the shoot to the growing point of the plants

2.2.2. Number of Shoots (Fruit): observed by counting emerging shoots
The Kruskal Wallis test with a significant level of 0.05 was carried out using SPSS 16.0 for Windows [12]. To analyze the data. In addition, the Dunnett’s test was performed to measure the difference.

3. Results and discussion

3.1. Results
The research was conducted in seven weeks. The treatment of bamboo shoot extract was given once a week. The parameters observed in the study were shoot height and numbers. The data obtained is presented in the following graphs and tables.

![Graph and table of shoots number growth](image)

**Figure 1.** The graph and table of shoots number growth.

Based on the table and graph above, it can be concluded that from the first week to the 7th, treatment A, B, C, and D resulted in the same number.
Based on figure 2, and from the results of the statistical tests, it can be seen that the treatment of bamboo shoot extracts with different concentrations gives different results on shoot height growth. To see the differences in each treatment, the Dunnett’s test was conducted. The test results can are presented in tables 1 and 2.

**Table 1.** Dunnett’s Test Result of Java apple stem cutting shoot numbers.

| Treatment | Week 1 | Week 2 | Week 3 | Week 4 | Week 5 | Week 6 | Week 7 |
|-----------|--------|--------|--------|--------|--------|--------|--------|
| A         | 12     | 1.5    | 1.7    | 1.7    | 1.8    | 1.8    |
| B         | 1.2    | 1.5    | 1.7    | 1.7    | 1.8    | 1.8    |
| C         | 1.2    | 1.5    | 1.7    | 1.7    | 1.8    | 1.8    |
| D         | 1.2    | 1.5    | 1.7    | 1.7    | 1.8    | 1.8    |
| E         | 16     | 1.7    | 2.2    | 2.4    | 2.6    | 2.6    |
| F         | 1.7    | 1.7    | 2.2    | 2.2    | 2.6    | 2.8    | 3.1    |

Notes: the same letter indicates insignificant differences

Based on table 1, a significant difference is seen in the seventh week, specifically treatment A and F, B and F, C and F and D and F.

**Table 2.** Dunnett’s test result of Java apple stem cutting shoot height.

| Perlakuan | Minggu ke 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|-----------|-------------|---|---|---|---|---|---|
| A         | 0.6^a       | 1.2^b | 1.7^b | 2.5^a | 3.1^b | 3.7^a | 4.2^b |
| B         | 0.8^ab      | 1.3^c | 2.1^ab | 2.9^ab | 3.4^ab | 4^ab | 4.6^b |
| C         | 0.9^ab      | 1.4^c | 2.3^bc | 3.5^bc | 4.2^bc | 4.6^bc | 5.1^b |
| D         | 1.1^ab      | 1.7^b | 2.7^cd | 3.8^c | 4.8^c | 5.5^b | 6.5^b |
| E         | 12^b        | 2.2^h | 3.1^d | 3.8^c | 5.7^d | 6.6^b | 7.1^b |
| F         | 1.2^b       | 2.4^b | 4.1^e | 5.2^d | 6.3^d | 8^e | 10^b |

Notes: the same letter indicates insignificant differences

Table 2 shows a significant difference in the number of treatments every week.
3.2. Discussions

In observing the number of shoots, a significant difference was only seen in the last week in treatment F only. This happens because the growth of shoots is influenced by the age of cuttings used. The number of shoot growth occurs very slowly because the age of the cuttings used is relatively old, more than ten years. While young cuttings have a low carbohydrate content but the hormones are so high that the appearance of shoots tends to be fast [13]. Significant differences also occur in treatment F (50%) only. This happen because the concentration cannot meet the need to accelerate the shoot growth. As Khandaker et al. said, the effect of a ZPT depends on plant species, sites of action of ZPT, stages of plant development and ZPT concentration [14].

The observation of shoot height found that there were significant differences from the first week to the last week. According to Rifai, gibberellins are growth-regulating substances that have a role in elongation of the stem (shoots) and suppresses the aging process and changes in plant organs [15].

Gibberelin is a hormone that accelerates seed germination, shoot growth, stem lengthening, leaf growth, stimulates inflorescence, fruit development, affects growth and differentiation [16]. In betung bamboo shoots, there is the gibberellin hormone. Apart from hormones, there is also an element of potassium of 533 mg which is a trigger for shoot height increase. It is also proven by potassium (K) which provides information that the higher the dosage of betung bamboo shoots extract is, the greater the K content found in the planting media of Java apple stem cuttings will become.

Ranghoo et al. states that physiologically the function of potassium is as follows [17]: metabolizing carbohydrates, nitrogen and protein synthesis, supervising and regulating the activities of various major mineral elements, neutralizing physiologically important organic acids, activating various enzymes, accelerating the growth of meristematic tissue, and regulating the movement of stomata and things related to water.

The important nutrient in bamboo shoot extract is P, K, and Ca. This elements are important for the growth of Java apple stem cuttings which are described as follows: Phosphorus functions as a building material and is bound in organic compounds. The function of calcium is to regulate the permeability of the cell walls and calcium salts to prevent the degree of acidity of cell water that works as a plant buffer. Potassium functions as forming supporting tissues (reinforcement) especially in leaves and stems, increasing cell wall permeability and assimilating cell charcoal [18].

4. Conclusion

Based on the results, data analysis and discussion, it can be concluded that:

1) The use of different concentrations of betung bamboo shoot extract (Dendrocalamus asper Backer ex Heyne) can increase Java apple stem cutting optimal growth (Syzygium samarangense) wherein the increase in growth occurred in treatment E (40%) and F (50%).

2) The most optimal concentration of betung bamboo shoot extract for Java apple (Syzygium samarangense) stem cutting optimal growth is 50% concentration. From the results of the study, it was found that 60% of the β-carotene concentration added to wet noodles had a significant effect on the durability in which wet noodles experienced a storage power of 4 days.

Acknowledgements

The author would like thank to Rektor IPI Garut, who has helped and facilitated the authors in conducting research and publications. Than the Faculty of FITS along with the Biology Education Study Program of the Institut Pendidikan Indonesia which has given permission and facilities for the implementation of this research.

References

[1] Prastowo N H 2006 Teknik Pembibitan dan Perbanyakan Vegetatif Tanaman Buah (World Agroforestry Center. Bogor)

[2] Hartmann H T and Kester D E 1983 Plant Propagation: Principle and Practices (New Jersey: Prentice Hall International Inc. Englewood Cliff)
[3] Campbell N A, Reece J B, Urry L A, Cain M L, Wasserman S A, Minorsky P V, Jackson R B 2008 *Biologi Jilid 2* (Jakarta. Erlangga) 315-409

[4] Pan X, Chang F, Kang L, Liu Y, Li G, and Li D 2008 Effects of gibberellin A3 on growth and microcystin production in Microcystis aeruginosa (cyanophyta) *Journal of Plant Physiology* 165 pp 1691-1697

[5] Bioma 2008 *Peranan Zat Pengatur Tumbuh (ZPT) dalam Pertumbuhan dan Perkembangan Tumbuhan* [Online] Retrieved from: http://mybioma.wordpress.com/. (Accessed: 05 maret 2016)

[6] Sobeh M, Esmat A, Petrük G, Abdelfattah M A O, Dmirieh M, Monti D M, Abdel-Naim A B, Wink M 2018 Phenolic Compounds from Syzygium jambos (Myrtaceae) Exhibit Distinct Antioxidant and Hepatoprotective Activities in Vivo *Journal of Functional Foods* 41 pp 223-231

[7] Djoukeng J D, Abou-Mansour E, Tabacchi R, Tapondjou A. L, Bouda H, and Lontsi D 2005 Antibacterial triterpenes from Syzygium guineense (Myrtaceae) *Journal of Etnopharmacology* 101 pp 283-286

[8] Trubus 2007 *Mikroba Jurus Masak Tanaman* (Jakarta. Trubus exo)

[9] Direktorat Jenderal Pendidikan Tinggi [DIKTI] 1991 *Kesuburan Tanah* (Jakarta: Departemen Pendidikan dan Kebudayaan)

[10] Rukmana R 1997 *Jambu Air (Tabulan pot)* (Yogyakarta. Kanisius)

[11] Park E. and Jhon D 2010 The Antioxidant, Angiotensin Converting Enzyme Inhibition Activity, and Phenolic Compounds of Bamboo Shoot Extracts (LWT- FOOD Science and Technology. Korea) pp 655-659

[12] Wattimena G A 1988 *Zat Pengatur Tumbuh Tanaman* (Pusat antar Universitas –IPB. Bekerjasama dengan Lembaga Sumberdaya informasi – IPB. Bogor)

[13] Binenbaum J, Weinstein R, and Shani E 2018 Gibberellin Localization and Transport in Plants *Trends in Plant Science* 23 pp 410–421

[14] Khandaker M M and Boyce A N 2016 Growth, Distribution and physiochemical properties of wax (Zygizyum samarangense) *Australian Journal of Crop Science* Malaysia

[15] Rifai T B and Sosrosoedirdjo R S 1998 *Ilmu Memupuk* (Jakarta. CV. Yasaguna Jakarta)

[16] Tian L-W, Xu M, Wang D, Zhu H-T, Yang C-R, and Zhang Y-J 2011 Phenolic Constituents from the Leaves of Syzygium forrestii Merr *And Perry Biochemical Systematic and Ecology* 39 pp 156-158

[17] Ranghoo M V, Chellan Y, Soulange J G, Lambrechts I, Stapelberg J, Crampton B, and Lall N 2019 Biochemical and Philogenetic Analysis of Eugenia and Syzygium Species from Mauritius *Journal of Applied Research on Medicinal and Aromatic Plants* 12 pp 21-29

[18] Sundayana R 2010 *Statistika Penelitian Pendidikan* (Garut: STKIP Garut Press)