ISBN : 978-602-5728-38-9

Proceeding of International Conference on Environmental and Science Education 2019

"Innovative Research Products in Science, Technology, and Conservation for The Development of 21st Century Education"

UNNES
Universitas Negeri Semarang

I.CESE
INTERNATIONAL CONFERENCE ON ENVIRONMENTAL AND SCIENCE EDUCATION

PERKUMPULAN PENDIDIK IPA INDONESIA
PPII

Semarang, April 27, 2019

Department of Integrated Sciences, Faculty of Mathematics and Natural Sciences
Universitas Negeri Semarang, Indonesia

PROCEEDING

INTERNATIONAL CONFERENCE ON ENVIRONMENTAL AND SCIENCE EDUCATION

"Innovative Research Products in Science, Technology, and Conservation for The Development of 21st Century Education"

Grasia Hotel Semarang, April 27th 2019

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INTEGRATED SCIENCE DEPARTMENT
FACULTY OF MATHEMATICS AND NATURAL SCIENCES
SEMARANG STATE UNIVERSITY
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ISBN 978-602-5728-38-9
First Edition, JUNE 2019

Publisher: FMIPA UNNES
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DEAN'S FORE WORDS

Dear Participants of ICESE 2019,

It is a pleasure to welcome all of you in the first International Conference on Environmental and Science Education (ICESE 2019) held by Integrated Science Department, Faculty of Mathematics and Natural Sciences, Semarang State University.

Faculty of Mathematics and Natural Science Semarang State University or more popularly known as FMIPA Unnes has 6 departments and 11 study programs of Mathematics and Natural Sciences education backgrounds and non-education backgrounds. FMIPA Unnes has the mission of being an excellent and meaningful faculty by improving human resources through scientific activity.

One of efforts to result excellent and meaningful human resources through scientific activity is by performing discussion and knowledge sharing. To widen discussion of science and research development in mathematics and science educations scopes in national and international level, ICESE 2019 was initiated as the medium of that discussion. I believe that ICESE 2019 can facilitate the knowledge sharing in environmental and science educations area in order to establish a global cooperation among experts and researchers.

With the hope that this conference will be the medium to optimize the role of Environmental, Science and Education in global cooperation, I am proud to welcome all of you and I wish you a pleasant sharing and discussion in this conference and enjoyable stay in Semarang, Indonesia.

Prof. Dr. Sudarmin, M.Si.

Dean of Faculty of Mathematics and Natural Sciences Semarang State University

CHAIRPERSON'S FORE WORDS

We welcome you to the First International Conference of Environmental and Science Education (ICESE) 2019 on April 27th in Semarang Indonesia. ICESE 2019 also the tenth national conference organized by Integrated Science Department, Faculty of Mathematics and Natural Science, Universitas Negeri Semarang. ICESE 2019 provides a platform to the research institutes, and industries to meet and share cutting-edge progress in the fields of environmental and science education as reflected in this year's theme "Innovative Research Products in Science, Technology, and Conservation for The Development of 21st Century Education".

This conference provides an opportunity to enhance understanding of the relationships between knowledge and research related to mathematics and science. The conference accepted 293 papers from 5 countries and 46 universities. The conference program represents the efforts of many people. We want to express our gratitude to the members of the Program Committee, and the reviewers for their hard work in reviewing submissions. We also thank to keynote speakers Prof. Fathur Rokhman, M. Hum., Prof. Dr. Ir. Purwanto DEA, Dr. Mary Margaret Thomas, Assoc. Prof. Dr. Haniza Hanim Mohd Zain, and Assoc. Prof. Chatree Faikhamta also the invited speaker all the participant. Finally, the conference would not be possible without the excellent papers contributed by authors. We thank all the authors for their contributions and their participation in ICESE 2019. We hope that this program will further stimulate research in Environmental and Science Education, share research interests and information, create a forum of collaboration and build trust relationship. We feel honored and privileged to serve the best recent developments in the field of Environmental and Science Education to you through this exciting program.

Wish you have great memorable event and enjoyable stay in Semarang.

Stephani Diah Pamelasari, S.S., M.Hum.

Chairperson of Conference Commitee

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Cultivation of Agarwood (*Aquilaria sp.)*: A Conservation Effort of Expensive Rare Plant

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Abstract. Agarwood is the blackish-colored wood and contains resins produced by species of genus/genus Aquilaria and Gyrinops, especially *A. malaccensis* and *G. versteegii*. The species is included in Appendix II because the population of agarwood-producing plants is vulnerable with a sharp decrease in its yield. In this research, the resin-producing agarwood plants were cultivated in the environment of Universitas Negeri Semarang to produce superior quality agarwood wood. The Completely randomized design was employed to treat the soil for agarwood planting using compost ranged from 0 kg to 1.5 kg each hole. The result showed that the highest fertilizer composition to optimally boost the growth of agarwood plants is 1-1.5 kg. This research was a form of conservation effort the scarce natural resources of the agarwood plant. By this research, rare agarwood plants were cultivated locally in the area of Universitas Negeri Semarang as an effort to save the Indonesian native agarwood germplasm that can be made as export commodities in the future.

INTRODUCTION

Agarwood is the blackish wood and contains a distinctive resin produced by several tree species from the genera Aquilaria and Gyrinops, especially *A. malaccensis* and *G. versteegii*. The resin produced by agarwood has a unique aroma that is frequently applied in the perfume industry. Agarwood has been leading as the main trading commodity from the Archipelago to India, Persia, the Arabian Peninsula, and East Africa since the beginning of the modern era around 2000 years ago.

The resin is widely traded with a very high selling price, especially for agarwood from the family plant Thymeleaceae with *Aquilaria spp*, which is called a *banyan* agarwood in Indonesia. The producing plants determine agarwood quality, and there is a lot of resin content in wood tissue. The higher the resin content in wood tissue, the selling price of agarwood will be more expensive, and vice versa (Rawana and Prijono, 2009).

In general, the trading of agarwood in Indonesia is classified into three major classes, namely *gubal, kemedangan*, and *abu*. *Gubal* has a characteristic of black or brownish black and can be obtained from parts of the agarwood-producing tree which has a strongly scented resin. *Kemedangan* is agarwood with a fragrant aroma and a physical appearance brownish to gray with crude fiber, and softwood. The last class is *abu*, which is the lowest quality level of agarwood which is produced from the wood powder produced by grating or the remaining wood as the final results of agarwood cutting (Siran, 2010).

Agarwood species *A. malaccensis* and *G. verstegii* are plants which are restricted for the trading purpose by the CITES Convention in the United States. The species is included in Appendix II because the population of agarwood-producing plants is shrinking in number (Compton and Ishihara, 2010; Turjaman et al. 2010). The lack of knowledge of the agarwood entrepreneurs in recognizing the resin content in agarwood plants leads them to cut the tree inappropriately. They cut down dozens of trees randomly, and they also cut down the trees that produce a small amount of resin. Therefore, agarwood trading must hold permission from CITES and in certain quota (TRAFFIC 2007). This rule is applied to ensure that natural agarwood tree species remains to survive (Akiko and Ishihara, 2010). Both genera of Aquilaria and Gyrinops agarwood need to be preserved by cultivating it inside and outside the forest area.

By this background, Universitas Negeri Semarang (UNNES), Indonesia as the conservation university has an effort to save rare natural resources of agarwood plants. Thus, with the implementation of this study, rare agarwood plants could be conserved and cultivated to save the wealth of native Indonesian agarwood germplasm. On the other hand, the efforts to produce superior agarwood with high export quality can be realized.

The purpose of this research was to cultivate resin-producing agarwood plants in the Universitas Negeri Semarang area to produce superior quality agarwood to support its sustainability for future utilization.

METHOD

1.1. Research Location
The research was conducted in the Faculty of Mathematics and Natural Sciences area and Educational Tourism Garden Universitas Negeri Semarang for six months.

1.2. Research sample
The sample in this research was 50 agarwood-producing plants (*Aquilaria malaccensis*) species obtained from a supplier of superior agarwood seedlings.

1.3. Research design
The first stage of this research was an exploratory study, began with the mapping of the campus area and the Educational Tourism Garden. The mapping had the purpose of seeing the potential space of the land area, which is still empty for planting agarwood plants. The sites were then prepared and processed to support the growth of agarwood plants by adding compost and rice straw. In parallel, *Aquilaria malaccensis* seeds were prepared for planting. Agarwood seeds were then inoculated into the prepared soil and treated intensively. Finally, the plant growth parameters were then measured and recorded.

1.4. Seed Selection
The initial preparation before cultivating agarwood plants was the selection of high-quality seeds. Seeds must be healthy without any threat of pests. At least, it has 1 cm trunk diameter and a minimum height of 20 to 30 cm. Also, the roots of these seeds have not penetrated the polybag. Agarwood seedlings obtained were then placed at the nursery location for two weeks to find out the percentage of survived agarwood plants before planting. During the two weeks, the plant maintenance was carried out by periodically watering and eradicating troublesome weeds.

1.5. Land preparation
Agarwood plants have genetic characteristics that are not resistant to direct sunlight with light intensity between 50-60% (Sumarna, 2005). The land in the research site was mapped with the ideal distance between two trees at 3 × 3 meters.

The survived and healthy agarwood seedlings are pre-selected to obtain relatively uniform plants for research purpose of measuring the growth parameters. Next, the first step before planting was making planting holes two weeks before planting. The ideal size of the planting hole is 30 cm × 30 cm × 30 cm. Planting of agarwood plants was carried out by the addition of compost and rice straw. The experimental design that was applied in this study is a completely randomized design with six treatments and ten replications (Table 1).

Table 1. Research design with completely randomized design

Treatment code	Treatment
K	Control (without compost), only rice straw
A	0.5 kg of compost and rice straw
B	0.75 kg of compost and rice straw
C	1 kg of compost and rice straw
D	1.25 kg of compost and rice straw
E	1.5 kg of compost and rice straw

1.6. Measurement of growth and development parameters

Preliminary data on growth and development parameters were measured right at the time after planting. Agarwood plant height, measured from the base of the stem (ground level) to the top growing point (shoots). Plant height measurements were carried out every month using a measuring bar, but those that were statistically analyzed were the last measurement data (1 month after planting). The measurement of the agarwood plants diameters was conducted at the base of the stem (fixed) using the calipers. Measurement of plant diameter was carried out every month using a caliper. Calculation of the number of branches and leaves was done every week.

1.7. Data analysis

The data analysis employed the analysis of variance (ANOVA) by SPSS Program. If the results obtained have a significant effect, then it was further tested with BNT at 95% confidence level.

RESULTS AND DISCUSSION

Agarwood is one of the forest plants with high economic value because of its expensive fragrant resin. The high-quality agarwood resin is mainly obtained from Aquilaria, Gyrinops, and Gonystylus. At present, the hunting of this wood in nature continues to increase where collectors do not only cut the dead trees but also cut down the living trees. Thus, this condition is further threatening the population and sustainability of agarwood production. In Indonesia, agarwood is very prospective to be developed, because it has biological potential in the form of a variety of agarwood-producing plant species, the extent of forest land suitable for the development of agarwood, and induction technology is available (Suharti 2010).

This research is one form of agarwood conservation efforts in the Universitas Negeri Semarang area. In this research, agarwood seeds were planted in the Faculty of Mathematics and Natural Sciences area and Educational Tourism Garden. The area was divided into 4 parts, namely A, B, C, and D. Part A is the location of planting near Building D3, while part B is vacant land near the student activity center building, part C included empty land behind the Chemistry Laboratory Building, and part D is an empty land along the belt outside the faculty and garden until Building D7. Compost fertilizer treatment had a significant effect on all parameters of agarwood plant growth, as shown in Table 2.

Table 2. The relative growth rate (RGR) of agarwood per day for four weeks (28 days) of observation, consisting of the relative growth rate of plant height (RGRh), number of leaves (RGRl), and trunk diameter (RGRt).

	Treatment	RGRh	RGRl	RGRt
K	Control (without compost), only rice straw	0.173^{a}	0.163^{a}	0.485^{a}
A	0.5 kg of compost and rice straw	0.361^{ab}	0.456^{bc}	0.465^{a}
B	0.75 kg of compost and rice straw	0.355^{ab}	0.566^{bcd}	0.557^{ab}
C	1 kg of compost and rice straw	0.464^{ab}	0.602^{cd}	0.574^{ab}
D	1.25 kg of compost and rice straw	0.528^{b}	0.817^{de}	0.6^{ab}
E	1.5 kg of compost and rice straw	0.425^{b}	1.062^{e}	0.644^{b}
BNT 5%		0.314	0.276	0.160

The number followed by the same letter in the same column is not significantly different from the 5% BNT test.

The highest relative plant growth rate (RGRh) was indicated by the treatment of 1.25 kg of compost (0.528%/day). It was significantly different from the plant RGRh without the treatment of compost with the lowest RGRh (0.173%/day). The percentage of another treatment of RGRh was between the two values and not significantly different. Plant response was relatively the same as RGRh, as indicated by the percentage growth rate of the relative number of leaves (RGRl) shows the same tendency. The treatment of giving 1.5 kg of compost had the highest RGRl (1.062%/day) and different levels with the treatment without compost, which gave the lowest growth rate (0.163%/day). Rate growth of stem diameter (RGRt) almost showed no difference between compost treatment, except between RGRt at 1.5 kg of compost and RGRt plants treated 0.5 kg of compost (0.644%/day vs. 0.485%/day). At the end of the observation, it was observed that the agarwood plant treated with 1.5 kg; 1.25 kg; and 1 kg of compost had more leaves (Table 3).

Table 3. Agronomic parameters of the growth of agarwood plants aged four weeks (28 days).

	Treatment	Height (cm)	Leaves	Trunk Diameter (cm)
K	Control (without compost), only rice straw	50.2	4.2^{a}	4.4
A	0.5 kg of compost and rice straw	66.1	14.3^{b}	6.6
B	0.75 kg of compost and rice straw	65.0	14.7^{b}	6.6
C	1 kg of compost and rice straw	65.5	15.7^{c}	6.8
D	1.25 kg of compost and rice straw	66.9	17.3^{d}	7.3
E	1.5 kg of compost and rice straw	66.3	18.0^{e}	6.9
BNT 5%		ns	0.59	ns

The number followed by the same letter in the same column is not significantly different from the 5% BNT test.

From all observations, it can be seen that the good growth of agarwood seedlings can occur if treated with compost and the intensity of sunlight at least up to 50% with lower temperature. CITES (2003) asserts that the agarwood plant is an understorey plant. In this study, agarwood plants were planted around the area of vacant land in the FMIPA environment, which had good shade. Riptiasih (2007) treated young agarwood in the layered net shade with variations in the number of layers. Nutrients and plant sensitivity to light are one of the essential factors in its growth. Some species are susceptible to high light intensity, unable to grow except under the shade. Adaptability to plants that are usually shaded to shade-free conditions is not common. Shade plants that are transferred directly to full-light conditions will experience barriers to photosynthesis continued by the falling of older leaves occurs in just a few days. Species that generally grow in shade conditions generally show low levels of photosynthesis in full light conditions, as well as full photosynthesis levels at lower radiation levels than sun plants (Salisburry and Ross, 1996). In this experiment, it was seen that plants experienced the worst conditions without compost treatment. The growth of agarwood with the treatment without compost looked very depressed since the beginning of the treatment. The leaves of this plant dry gradually from the edges of the leaves, then fall. After a portion of the leaves fall, new shoots will appear. However, these shoots failed to continue growing.

Compost is one type of organic fertilizer made from the process of decomposing the remains of plants and animals with the help of living organisms. The main raw materials for making compost are organic material and decomposers. The decomposing organisms used can be microorganisms or macroorganisms. Composting technology is the process of decomposition of organic material that occurs in nature as happens in hummus. The composting managed by the human can be done in a shorter time. Compost fertilizer can be made easily and the technology is simple. Making compost can be done by everyone on a large scale on a scale of agriculture or small scale, which is just the needs of the yard. In addition to its role in providing nutrients for plants, compost can also improve the physical, chemical, and biological structure of the soil. Compost plays a role in increasing the ability of the soil to store water as a reserve in times of drought. Besides, compost can also make the soil loose and suitable as a medium for growing plant roots. Compost can be used as an adhesive on sand type soil becomes solid. Plants can easily absorb cations in the soil. Biologically, compost is a suitable medium for soil organisms to breed so that the activity of microorganisms and soil animals will enrich the soil with essential nutrients for plants. The rice straw supports the growth of agarwood seeds by absorbing the water from the soil. In addition, it can store the water as a stock for the plant. Therefore, in a dry season, the use of rice straw will be beneficial. By these features, compost and rice straw could help agarwood plants to grow properly.

CONCLUSION

This research proved that the agarwood plants need nutrients from compost for its growth, especially its growth at the seedling level. Compost fertilizer with an amount of 1-1.5 kg provided better growth of agarwood plants. Also, the shade conditions of agarwood plants affect the growth of these plants; the agarwood plants can grow normally under the shade plants. By the agarwood planting program, the conservation effort of agarwood germplasm can be achieved.

ACKNOWLEDGEMENT

This research was supported by DIPA FMIPA Universitas Negeri Semarang 2016 under the scheme of Education and Conservation Researches Number 15.30.6/UN37/PPK.4.4/2016, 30 June 2016.

REFERENCES

Compton, J., & Ishihara, A. (2004). The use and trade of agarwood in Japan. A TRAFFIC report to the CITES Secretariat, 6, 1-21.

CITES, 2003. Review of Significant Trade *Aquilaria malaccensis* (November 2003). CITES Document No. PC14 Doc. 9.2.2, Annex 2

Rawana & Prijono, A. (2009). Etnobotani pohon agarwood (*Aquilaria sp.*) Sebagai sumber bahan obat alami". *Seminar Nasional Bahan obat alam di Universitas Sanata Darma Yogyakarta 2009*

Riptiasih. (2007). Pengaruh beberapa tingkat naungan terhadap pertumbuhan tanaman agarwood muda. Skripsi S1 (Pembimbing T Mulyaningsih dan N Farida). Fakultas Pertanian Universitas Mataram.

Salisbury, F B & Ross, C.W. (1996). *Plant Physiology*. Wadshworth Publishing Company. Belmount California.

Siran, S. A. (2010). Perkembangan pemanfaatan agarwood. Pengembangan Teknologi Produksi Agarwood Berbasis Pemberdayaan Masyarakat. Bogor, Indonesia, 1-29.

Suharti, S. (2009). Prospek pengusahaan agarwood melalui pola pengelolaan hutan berbasis masyarakat (PHBM). *Pusat Litbang dan Konservasi Alam. Bogor.*

Sumarna, Y. (2005). Strategi Budidaya dan Pengembangan Produksi Agarwood. in: Peluang dan Tantangan Pengembangan Agarwood di Indonesia. *Biotrop*

TRAFFIC Southeast Asia (Eds). (2007). Proceedings of the Experts Group Meeting on Agarwood: Capacity-building Workshop for Improving Implementation and Enforcement of the CITES listing of *Aquilaria malaccensis* and other Agarwood-producing species. Kuala Lumpur. 14-17 November 2006.

Turjaman, M., I.R. Sitepu, R.S.B. Irianto, S. Sentosa, Aryamto, A. Yani, Najmulah and E. Santoso. (2010). Penggunaan Fungi Mikoriza Arbuskula Pada Empat Jenis A. beccariana. Dalam : Pengembangan Teknologi Produksi Agarwood Berbasis Pemberdayaan Masyarakat. Pusat Penelitian dan Pengembangan Hutan dan Konservasi Alam. Bogor. 139-150.